THE FOOD AND FEEDING OF FARMED FISH AND SHRIMP
AN ANNOTATED SELECTION OF FAO FIELD DOCUMENTS, 1973-1991

by

Albert G.J. Tacon
Fishery Resources Officer (Feed Specialist)
Inland Water Resources and Aquaculture Service
Fishery Resources and Environment Division

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PREPARATION OF THIS DOCUMENT

This document was prepared as part of the ongoing activities of the FAO Inland Water Resources and Aquaculture Service to assist field staff and projects with the implementation of aquaculture development activities related to the food and feeding of farmed fish and shrimp. For the purposes of this document food and feeding includes pond fertilization through direct application or livestock-integration, composting, live food production, and artificial diet feeding.

A prerequisite to the planning and implementation of a research and development activity on the food and feeding of farmed fish or shrimp is first to be aware of the previous studies conducted in this subject area by other related field projects, and by so doing avoiding unnecessary duplication of research effort and the re-invention of the wheel.

The 326 reports listed in this document were produced by 68 FAO field projects between 1973 and 1991. It does not include the reports produced by the FAO Regular Programme and FAO regional bodies as these have been covered in similar lists published in the same series as follows:

(i) **A list of selected FAO publications related to aquaculture, 1966-1989.**
FAO Fish.Circ., (744)Rev.2:60 p. 1990

(ii) **Selected aquaculture publications: serials, newsletters, meeting proceedings, and bibliographies/directories/glossaries.**
FAO Fish.Circ., (808)Rev.1:133 p. 1991

Micro CDS/ISIS software was used for the production of this circular and records, where available, extracted from the FAODOC database of the David Lubin Memorial Library. In this respect, the assistance of Ms Jean Collins, Librarian, Fisheries Branch Library, is greatly appreciated.

It is planned that subsequent revisions will make it possible to keep these lists current. Suggestions of modifications which should be introduced would be welcome from users. They should be addressed to the Inland Water Resources and Aquaculture Service (FIRI), FAO, 00100 Rome, Italy.

Tacon, A.G.J.
The food and feeding of farmed fish and shrimp. An annotated selection of FAO field documents, 1973-1991.
FAO Fisheries Circular. No. 849. Rome, FAO. 1992. 92 p.

ABSTRACT

The document presents an annotated list of 326 selected FAO field reports concerned with or containing relevant information on, the food and feeding of farmed fish and shrimp, including pond fertilization through direct or livestock integration, live food production, and artificial diet feeding. The reports presented were produced during the activities of 68 FAO field projects between 1973 and 1991. Reports are listed by project for individual countries or by region. Author, country and genera indexes are provided.

FAO Fisheries Circular (FAO Fish.Circ.)

A vehicle for distribution of short or ephemeral notes, lists, etc., including provisional versions of documents to be issued later in other series.

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I. NATIONAL PROJECT REPORTS

BANGLADESH

1. **Fisheries Research Institute**, Dhaka (Bangladesh). July 1986. Research plans for nutrition and feed technology. Dhaka (Bangladesh). 146 p. Microfiche no: 87X01060.
Project: BGD/83/010 - Assistance to the Second Agricultural Research. Report 4.

   The report is based on the results of a two month consultancy by Professor J.E. Halver charged with developing the capabilities of the Fisheries Research Institute for research in fish nutrition and feed technology. The report is presented under the following headings: 1) introduction; 2) nutrition laboratory capability; 3) research programme planning; 4) national fish feedstuffs survey; 5) laboratory scale experimental feed mill; 6) recommendations; and 7) further nutrition consultancy.

2. **Fisheries Research Institute**, Dhaka (Bangladesh). September 1986. Research plans for integrated aquaculture. Dhaka (Bangladesh). 58 p. Microfiche no: 87X01063.
Project: BGD/83/010 - Assistance to the Second Agricultural Research Project. Report 7.

   The report provides detailed plans for a 5-year research programme on integrated aquaculture; including 1) the development of a package of technology for integrated fish-livestock (ducks and chicken)-crop farming systems, appropriate to the existing socio-economic conditions of the country, 2) the testing of these technology packages using on-farm tests, and 3) the training of farmers in different integrated farming systems.

3. **Fisheries Research Institute**, Dhaka, Bangladesh. April 1989. Development of Artemia culture in Bangladesh. Arnhem (Netherlands). 115 p.
Project: BGD/83/010 - Assistance to the Second Agricultural Research.

   The report describes the results of a six week consultancy of an Artemia specialist assigned to the Fisheries Research Institute (FRI) in Bangladesh. The consultant was charged with the identification of sites suitable for the production of Artemia and with the preparation of a detailed research project for the development of Artemia culture to be carried out at the Marine Fisheries Research Station (MFRS) of FRI in Cox's Bazar.

4. **Halver, J.E.** March 1987. Progress in nutritional research. Dhaka (Bangladesh). 11 p. Microfiche no: 88X01064.
Project: BGD/83/010 - Assistance to the Second Agricultural Research Project. Report 17.

   The report is presented under the following main headings: 1) review of progress in nutrition, feed technology and diet testing; 2) amended nutrition and diet development program; 3) experimental feed mill development; 4) training; and 5) diet testing capabilities. Recommendations of the project are included.

5. **Halver, J.E.** June 1989. Progress in nutrition and diet development research. Nutrition consultancy report, 30 April - 31 May 1989. Arnhem (Netherlands). 66 p. Microfiche no: 304763.
Project: BGD/83/010 - Assistance to the Second Agricultural Research.

   The report reviews the progress in nutrition and diet development at the Freshwater Aquaculture Research Station in Mymensingh, Bangladesh. Information is provided on the fish feeding trials conducted at the station and recommendations given for the next biennium, including specifications for compound feed manufacture.

6. Nandi, S.; Peteri, A. May 1991. Progress report of the hatchery/fry/fingerling production component (Period: November 1990 - April 1991), Appendix E. Dhaka (Bangladesh). 93 p.
Project: BGD/87/045 - Institutional Strengthening in the Fisheries Sector.

The report summarizes the techniques developed by the project for the production of Indian carps and African catfish fingerlings in Bangladesh. Ten annexes are attached to the main report, including a major review and training manual on fish seed production; the latter reviewing the pond fertilization and feeding methods employed within Bangladesh.

7. Varga, I.; Rahman, M.M. May 1991. Progress report on integrated fish culture component (Period: November 1990 - April 1991), Appendix D. Dhaka (Bangladesh). 106 p.
Project: BGD/87/045 - Institutional Strengthening in the Fisheries Sector.

The report summarizes the activities of the project concerning the development of integrated semi-intensive farming systems in Bangladesh for Indian carp and African catfish with chickens or ducks. Four annexes are attached to the main body of the report, including a report on the development of table size Magur (Clarias gariepinus) and a training manual on integrated semi-intensive fish culture. Within the report information is presented on the fertilizer and feeding practices employed within semi-intensive integrated fish farms in Bangladesh.

CENTRAL AFRICAN REPUBLIC

8. Behaghel de Bueren, L. 1985. Les graines de coton et leur utilisation pour la pisciculture en zone est de RCA. Bambari (Central African Republic). 41 p. Microfiche no: 87X00213.
Project: CAF/80/002 - Vulgarisation de la Pisciculture et Autofinancement des Stations Piscicoles Principales. Document Technique 26.

The report is concerned with an evaluation of cottonseed and its by-products as a fertilizer and feed for aquaculture in the Central African Republic. The results of various pond culture trials with Tilapia nilotica utilizing cottonseed as a fertilizer or feed input are presented.

9. Chow, K.W. 1984. Fish feed requirements and manufacture, Central African Republic. Rome (Italy). 11 p. Microfiche no: 85W00205.
Project: GCP/CAF/007/NET - Hatchery Production and Research Centre at Bangui-Landjia. Field Document 2.

This report summarizes the consultant's findings made during the period 7 to 17 November, 1983, concerning the supply of feed ingredients to meet both present and future needs of the station and the state of existing feed manufacturing machinery and their need for repairs and upgrading. It also includes a brief description of repairs carried out on the machinery during the period, and construction of equipment for moist pelleted feed production. Feed ingredients available in Bangui are discussed and suggested feed formulation for Clarias are presented.

10. Eding, E.H. 1984. Larval rearing and fry production at La Landjia Hatchery, Central African Republic. Rome (Italy). 32 p. Microfiche no: 85W00204.
Project: GCP/CAF/007/NET - Hatchery Production and Research Centre Project at Bangui-Landjia. Field Document 3.

The report discusses the methods employed at the La Landjia Hatchery in the Central African Republic for the production of Clarias lazera larvae and fry. The report is presented under two main headings: 1) nursery operations for the production of larvae, including broodstock conditioning, artificial reproduction, egg incubation, Artemia hatching, Artemia-fed larvae, larvae fed with dry pelleted food, the cost of larval production on the basis of food consumption, and scaling-up larvae production; and 2) handling of eggs and larvae and prevention of diseases, including water quality improvement, improvements in farming techniques (i.e. feeding), and prophylactic treatment.

11. **Janssen, J.** March 1983. Perfectionnement de la technique de decapsulation de cystes d'Artemia. Bangui (Central African Republic). 7 p. Microfiche no: 87X00195.
Project:GCP/CAF/007/NET - Hatchery Production and Research Centre at Bangui-Landjia. Note Technique 20.

The report describes a simple method for the decapsulation of Artemia cysts using a calcium hypochlorite solution.

12. **Janssen, J.** May 1985. Elevage du poisson-chat africain Clarias lazera (Cuv and Val., 1840) en Republique Centrafricaine. I: Propagation artificielle. Bangui (Central African Republic). 107 p. Microfiche no: 87X00207.
Project: GCP/CAF/007/NET - Hatchery Production and Research Centre at Bangui-Landjia. Document Technique 20.

The report describes the artificial propagation techniques employed within the Central African Republic for the African catfish Clarias lazera. Information is provided on hormone treatment, manual extraction of eggs and their fertilization, and broodstock rearing methods, including broodstock feeding.

13. **Janssen, J.** September 1985. Elevage du poisson-chat africain Clarias lazera (Cuv and Val.,1840) en Republique Centrafricaine. III: Alevinage et grossissement en etangs. Bangui (Central African Republic). 35 p. Microfiche no: 87X00209.
Project:GCP/CAF/007/NET - Hatchery Production and Research Centre at Bangui-Landjia. Document Technique 22.

The rearing of catfish fingerlings in ponds is discussed, describing the preparation of the pond, fertilization, feeding and draining methods. Growth in the ponds in monoculture or polyculture with Tilapia nilotica is examined, detailing all stages involved from preparation of the pond, to draining and commercialization. Factors affecting the survival and growth of the fish are also considered.

14. **Janssen, J.** 1985. Elevage du poisson-chat africain Clarias lazera (Cuv and Val., 1840) en Republique Centrafricaine. IV: Alimentation. Bangui (Central African Republic). 51 p. Microfiche no: 87X00210.
Project: GCP/CAF/007/NET - Hatchery Production and Research Centre at Bangui-Landjia. Document Technique 23.

A description is given of agricultural products and by-products available in the Central African Republic and their use as feed for small fish. The formulation of different artificial feeds for Clarias lazera at different stages of rearing is described, detailing also equipment used.

15. **Janssen, J.** June 1985. Elevage du poisson-chat africain Clarias lazera (Cuv & Val., 1840) en Republique Centrafricaine. II: Alevinage en ecloserie. Bangui (Central African Republic). 52 p. Microfiche no: 87X00208.
Project: GCP/CAF/007/NET - Hatchery Production and Research Centre Project at Bangui-Landjia. Document Technique 21.

Details are given of the rearing of juvenile catfish (Clarias lazera) under controlled conditions in the Central African Republic. Following a description of the technology used to rear catfish larvae, including feeding methods, sanitary measures taken to ensure good growth and survival are described. The methods used to transport alevins are outlined, detailing also the personnel required. The cost of rearing alevins is also presented.

16. **Janssen, J.** 1984. Calcul et analyse des prix de revient des fingerlings de Clarias lazera et de l'alimentation. Bangui (Central African Republic). 20 p.
Project: GCP/CAF/007/NET - Hatchery Production and Research Centre Project at Bangui-Landjia. Note Technique 25.

The report is concerned with an economic analysis of the cost of producing catfish (Clarias lazera) fingerlings in the Central African Republic. The cost of fingerling production is evaluated on the basis of using different dietary feeding regimes, including the use of dry and moist diet formulations in pelleted or non-pelleted form. Recommended sale prices for catfish fingerlings for the Landjia Aquaculture Centre are given.

17. Lietar, C. March 1984. L'elevage du Tilapia nilotica en RCA. Manuel pour les animateurs piscicoles. Bangui (Central African Republic). 51 p. Microfiche no: 87X00198.
Project: CAF/80/002 - Vulgarisation de la Pisciculture et Autofinancement des Stations Piscicoles Principales. Cours de Formation 2.

The manual is concerned with the culture of Tilapia nilotica in the Central African Republic and deals with site selection, pond farming systems, pond construction, and rearing techniques including food and feeding methods.

18. Miller, J.W.; Maletoungou, Z. 1976. Evaluation des productions piscicoles diverses au Centre Piscicole de la Landjia. Bangui (Central African Republic). 48 p. Microfiche no: 87X00187.
Project: CAF/72/002 - Vulgarisation de la Pisciculture.

The report discusses the production methods for Tilapia nilotica and Clarias lazera developed and tested at the Landjia aquaculture centre in the Central African Republic, with particular reference to the formulation and testing of rations using locally available brewery by-products either in mash or pelleted form, and integrated fish-pig production systems.

CHINA

19. Kungvankij, P. May 1988. Hatchery management techniques in marine fish culture development. Rome (Italy). 17 p. Microfiche no: 88M01599.
Project: CPR/81/014 - Development of Coastal Aquaculture. Field Document 1.

The report described project activities conducted regarding the development of culture techniques for marine finfish (Mugil sp.) seed production in the coastal areas of China. Larval feed development and hatchery management are discussed in detail. Conclusions and recommendations of the project are included.

20. Kungvankij, P. June 1988. Guide to the production of live food organisms. Rome (Italy). 23 p. Microfiche no: 88W01675.
Project: CPR/81/014 - Development of Coastal Aquaculture. Field Document 2.

Details are given of project activities regarding selection of food for rearing of fish larvae in the coastal areas of China. Most commonly used live foods include: rotifers, molluscan larvae, phytoplankton and brine shrimp nauplii. Phytoplankton culture is discussed in detail, considering the various types of algal culture, sampling/isolation techniques, growth and conditions affecting growth.

21. Kungvankij, P. June 1988. Guide to marine finfish hatchery management. Rome (Italy). 19 p. Microfiche no: 88W01674.
Project: CPR/81/014 - Development of Coastal Aquaculture. Field Document 3

Details are given of project activities conducted regarding the setting up of a fish culture hatchery for marine fish in the coastal areas of China. To ensure effective operation, the following facilities were required: holding tanks, seawater intake system, water supply system and aeration system. Management of various phases involved in hatchery operation is discussed in detail, considering: 1) broodstock development; 2) collection of wild broodstock; 3) broodstock; 4) spawning and fertilization; 5) spawning; 6) fertilization and incubation; 7) larval rearing; 8) factors affecting mass rearing; 9) rearing environment; and 10) feed and feeding.

22. **Meyers, S.P.** July 1987. Development of a pilot demonstration plant for compound fishfeed. Rome (Italy). 18 p.
Project: TCP/CPR/6760 - Development of a Pilot Demonstration Plant for Compound Fish Feed. Field Document 1.

An evaluation of compound feed ingredients and relevant feed plant requirements has been conducted pursuant to the development of a fish feed demonstration plant in Shaoxing County, Zhejiang Province, People's Republic of China. The two components of the project, i.e., plant development/installation logistics and compound feed demonstration, have been identified and procedures proposed for their implementation. Priority items have been identified along with a necessary proposed schedule to achieve project goals. Technical liaison has been established to insure continuity in transfer of feed formulation information and optimization of the compound feeds produced. To meet project goals it is recommended that the present termination date be extended through 1988.

23. **Primavera, J.H.** December 1987. Improved techniques for prawn breeding. Rome (Italy). 18 p. Microfiche no: 88W00528.
Project: CPR/85/080 - Demonstration of Prawn Culture in Xincun. Field Document 1.

An evaluation was made of available hatchery facilities and existing procedures (including feeding strategy) in order to plan out a strategy for captive broodstock and maturation for the prawn Penaeus orientalis in Xincun, China. Information on the life history of the species was valuable in outlining specific activities in three general areas of the breeding process; spawning, induced maturation, and overwintering of broodstock. Facilities and equipment required to support the breeding effort are identified including a maturation building and tanks for maturation and spawning. Finally, training was given to the project staff in the form of lecture-slide presentations and discussions in preparation for the April-May 1988 breeding work.

24. **Tacon, A.G.J.** November 1990. Fish feed formulation and production. Rome (Italy). 29 p. Microfiche no: 309187.
Project: CPR/88/077 - Fisheries Development in Qinghai Province. Field Document 8.

This report details the results of a consultancy carried out to develop rainbow trout feeds using locally available ingredients and machinery for use at the Project trout farms in Qinghai Province. Baseline data on the agricultural feed resources of Qinghai Province are summarised, and local agricultural and industrial by-products identified for potential use within fish feeds. On the basis of the feed resources and machinery available, a dry diet formulation and feeding regime is recommended for use at the Project's trout farms. It is recommended that three distinct feed lines be produced (starter, fingerling, and production), and that the diet be manufactured for the Project by a local animal feed manufacturer in Xining. Details of the proposed formulations and feeding regimes are fully described.

COLOMBIA

25. **New, M.B.** October 1977. A review of progress in the Colombian Macrobrachium programme. Rome (Italy). 15 p.
Project: COL/71/552 - Inland Water Fisheries Development Project.

A report of the progress made in the FAO Macrobrachium programme in Colombia between August 1976 and September 1977 is presented. A review of larval rearing studies is provided together with an account of the consultant's activities during his four week visit to Cartagena. Post-larval prawn diets were formulated and made and a course in animal feedstuff technology and prawn nutrition given. The FAO contribution to prawn rearing in Colombia is documented and recommendations for future work included.

COTE D'IVOIRE

26. **Campbell, D.** July 1978. Formulation des aliments destines a elevage de Tilapia nilotica (L.) en cages dans le lac de Kossou, Cote d'Ivoire. Kossou (Cote d'Ivoire). 27 p.
Project: IVC/71/526 - Developpement de la Peche du Lac de Kossou. Rapport Technique 46.

The report presents the results of cage feeding trials conducted with Tilapia nilotica in Lake Kossou, Cote d'Ivoire. Diets were formulated using locally available feed ingredients and the results analyzed from a nutritional and economic viewpoint. The results indicated that the addition of a dietary vitamin premix had no beneficial effect on the growth of fish; fish apparently satisfying their nutritional demands from the consumption of natural food organisms within the water body.

27. **Nugent, C.** 1985. Les aliments du poisson: une intervention du projet dans leur preparation et leur distribution. Bouake (Cote d'Ivoire). 11 p.
Project: IVC/84/001 - Developpement de la Pisciculture en Milieu Rural. Document Technique 17.

The report describes the activities of the project in Cote d'Ivoire concerning the formulation and preparation of simple compound feeds for fish (Tilapia and catfish sp.) using locally available ingredients and machinery. Information is presented on the cost of manufacturing feed mashes and pellets, and concerning feed management and handling.

28. **Shehadeh, Z.H.** April 1974. Ivory Coast - A preliminary evaluation of the potential for cage culture of fish in Lake Kossou. Rome (Italy). 27 p. Microfiche no: 43539.
Project: IVC/71/526 - Developpement de la Peche du Lac de Kossou.

The report discusses the availability of fish species suitable for cage culture and the availability of suitable sites within Lake Kossou. In addition, information is presented on the local feed ingredients available in Bouake/Abidjan (including chemical composition and cost) and concerning the preparation of feeds for cage-rearing tests with Tilapia nilotica and Clarias lazera. Cage materials and cage construction is also discussed and recommendations given for the implementation of a one to two year research programme.

CUBA

29. **Servizi Tecnici in Maricoltura,** S.T.M., Padova (Italy). 1991. Reproduccion controlada de peces marino y cultivo de su alimento vivo. Padova (Italy). 49 p.
Project:TCP/CUB/0052 - Desove Inducido y Cria de Larvas de Peces Marinos.

The report summarizes the activities of the consultant concerning the development of techniques for the controlled reproduction of marine finfish (ie. Gerreidae, Mugilidae and Lutjanidae) and the production of live food organisms (ie. algae, rotifers and copepods) in Cuba.

30. **Carles, D.** March 1990. Asesoria en maduracion de camaron. Mision del 06/05/1989 al 27/10/1989. Paris (France). 75 p.
Project: CUB/86/004 - Asistencia para el Desarrollo del Cultivo del Camaron en Cuba.

The report summarizes the activities of the consultant concerning the development of penaeid shrimp maturation techniques. Information is presented on the capture and management of the broodstock prior to spawning (including the importance of food and feeding during the maturation process), egg and larval larval development, and sanitation.

31. **Chim, L.** January 1989. Consultoria en cultivo de camaron. Mision del 16/07/88 al 24/12/88. Paris (France). 138 p. Microfiche no: 307971.
Project: CUB/86/004 - Asistencia para el Desarrollo del Cultivo del Camaron en Cuba.

The report summarizes the activities of the consultant on the development of shrimp farming in Cuba and in particular concerning the activities of the Rio Cauto and Tunas de Zaza shrimp farms. Information is presented on the water and pond management practices employed, including the food and feeding of the cultured shrimp.

32. **Cuzon, G.** July 1988. Consultoria en nutricion de camarones. Mision del 12/04/88 al 04/05/88. Paris (France). 33 p.
Project: CUB/86/004 - Asistencia para el Desarrollo del Cultivo del Camaron en Cuba.

The report summarizes the activities of the consultant concerning the development of practical feeds for penaeid shrimp in Cuba. Least-cost diet formulations are presented for larval and juvenile shrimp using locally available ingredient sources and recommendations given for diet development for the entire culture cycle.

33. **Doucet, J.** December 1989. Asesoria en cria larval y produccion de fitoplancton. Mision del 06/05/1989 al 27/10/1989. Paris (France). 77 p.
Project: CUB/86/004 - Asistencia para el Desarrollo del Cultivo del Camaron en Cuba.

The report summarizes the activities of the consultant concerning the development of larval rearing techniques for penaeid shrimp and the production of phytoplankton as larval food.

34. **Garen, P.** February 1987. Tecnicas de camaronicultura de ciclo cerrado: la cria de progenitores en cautiverio. Mision del 6/01/87 al 23/01/87. Paris (France). 57 p.
Project: CUB/86/004 - Asistencia para el Desarrollo del Cultivo del Camaron en Cuba.

The report summarizes the activities of the consultant concerning the development of production techniques for penaeid shrimp within a closed farming system and in particular the culture of potential broodstock shrimp. Semi-intensive and intensive culture techniques are detailed, including pond fertilization and shrimp feeding methods.

35. **Laborieux, J.** April 1991. Asesoria en la cria del camaron, ingenieria acuicola y ingenieria nutricional. Mision del 30/09/90 al 28/11/90. Paris (France). 69 p.
Project: CUB/86/004 - Asistencia para el Desarrollo del Cultivo del Camaron en Cuba.

The report summarizes the activities of the consultant concerning the shrimp farming methods employed within selected shrimp production centres in Cuba. In addition, information is presented on the production of compound shrimp feeds in Cuba and concerning the feed formulations and feeding regimes employed within the shrimp production centres visited.

36. **Laine, J.J.** April 1991. Asesoria en la cria de Artemia. Mision del 16/01/91 al 16/02/91. Paris (France). 48 p.
Project: CUB/86/004 - Asistencia para el Desarrollo del Cultivo del Camaron en Cuba.

The report is concerned with an evaluation of the Artemia culture project in Cuba, and in particular, concerning the production of Artemia cysts and biomass in earthen ponds.

37. **Le Begue, E.** 1990. Asesoria en cria larval. Mision del 23/04/1990 al 15/06/1990. Paris (France). 51 p. Microfiche no: 303989.
Project: CUB/86/004 - Asistencia para el Desarrollo del Cultivo del Camaron en Cuba.

The report summarizes the results of the project concerning the development of larval rearing techniques for penaeid shrimp in Cuba, including the production of Artemia salina and phytoplankton (Chaetoceros sp. and Tetraselmis sp.) as food organisms for the cultured shrimp. Information is also presented on disease problems, bacteriology and hatchery sanitation.

38. **Menu, B.** October 1988. Consultoria en Artemia salina. Ira. Mision del 23/07/88 al 02/09/88. Paris (France). 44 p. Microfiche no: 307977.
Project: CUB/86/004 - Asistencia para el Desarrollo del Cultivo del Camaron en Cuba. Informe Tecnico de la serie No.5.

The report summarizes the activities of the consultant concerning the production of Artemia salina in Cuba. Information is presented on the technical and biological characteristics of the salt ponds/lagoons in Cuba, the production of Artemia cysts within these water bodies, and concerning the treatment and processing of Artemia cysts and biomass.

39. **Wickins, J.F.** 1990. The culture of the giant freshwater prawn (Macrobrachium rosenbergii de Man) in Cuba. Rome (Italy). 46 p.
Project: TCP/CUB/8956 - Cultivo del Langostino.

The report summarizes the spawning systems and grow-out methods employed in selected Cuban hatcheries and farms for Macrobrachium rosenbergii. An evaluation is made of the food and feeding methods employed within the El Dique hatchery and recommendations given for the development of larval feeds using locally available ingredient sources.

EGYPT

40. **Chow, K.W.** May 1982. Artificial feeding for polyculture of carp, tilapia and mullet at the Zaweya Fish Farm, Egypt. Rome (Italy). 12 p. Microfiche no: 8225591-E.
Project: EGY/80/002 - Aquaculture Demonstration and Training. Field Document 1.

As part of a UNDP/FAO project a consultant was engaged: 1) to evaluate locally-available ingredients for fish feed; 2) to provide advice and assistance in the formulation and preparation of fish diets; 3) to undertake the evaluation of the economics of feeding fish in farms under local conditions. The results, comments and recommendations of the consultant are reported.

GHANA

41. **Agyenim-Boateng, C.E.; Vincke, M.M.J.; Wijkström, U.N.** August 1990. Manures and agro-industrial by-products for fish-farming in Ghana. Rome (Italy). 16 p.
Project: TCP/GHA/0051 - Technical Assistance and Investment Framework for Aquaculture in Ghana. Field Working Paper 4.

The paper reviews the present and likely future availability of manures, including chemical fertilizers, and agro-industrial by-products in Ghana. In addition an assessment of their potential contribution as major inputs to a national aquaculture development strategy is made.

42. **Vincke, M.M.J.; Awity, L.K.A.** August 1990. Description and assessment of fish farms in Ghana. Rome (Italy). 29 p.
Project: TCP/GHA/0051 - Technical Assistance and Investment Framework for Aquaculture in Ghana. Field Working Paper 10.

The report describes the farming activities employed within private, government and parastatal fish farms, and research facilities in Ghana. Comments on the farms and their management, including the feeding methods employed, are given and recommendations concerning rehabilitation to government farms, improved management practices and priorities for supporting research are made.

GREECE

43. **Matty, A.J.** October 1987. Fish feed technology and fish nutrition, Greece. Rome (Italy). 22 p. Microfiche no: 88W00412.
Project: GRE/85/002 - Development of Marine and Inland Aquaculture. Field Document 3.

Details are given of a project conducted regarding the production of processed feed for the aquaculture industry in Greece. The present situation of applied research and development in fish feeds and utilization in the country is examined. Fish species cultured include: trout, eel, carp, seabream, seabass and mullet. Pellet feed, silage, larval nutrition and feeding, and feed resources are discussed, and the impact of feed cost and quality on production economics considered.

HUNGARY

44. **Halver, J.E.** February 1978. Hungarian People's Republic - Fish nutrition consultancy. Rome (Italy). 11 p. Microfiche no: 39168.
Project: HUN/71/512 - Development of Fish Culture Research. Report HUN/71/512/5.

Fish nutrition and diet development research at the National Fishery Research Institution (HAKI) were reviewed and a master plan for reorganization of research into seven major areas elaborated and adopted by the scientific director. The master formulae for compressed pellet manufactured by the feed mill were reviewed and extended to include levels of indispensable amino acids in the feedstuffs, and techniques to assure proper weights and measures were demonstrated. A master plan for fish nutrition research to determine the quantitative protein requirements of Silurus fingerlings was developed. Indirect estimates of indispensable amino acid requirements of Silurus based on protein requirements were elaborated. Test diet treatments were designed and preliminary trials and diet treatments to determine the indispensable amino acid requirements for probable limitation of amino acids were planned for the years 1978-1980. Linear programming techniques for least cost dual variable computer formulation of diets made by the experimental feed mill were demonstrated. Recommendations for the development of an integrated fish nutrition and diet development research programme using the scientific manpower and facilities available at HAKI were made to the scientific director and to the head of the nutrition research section.

45. **Halver, J.E.** 1982. Fish nutrition and diet development; a report. Rome (Italy). 11 p. Microfiche no: 8227285-E.
Project: HUN/79/001 - Development of Intensive Freshwater Fish Culture. Field Document 3.

The report is presented under the following headings, namely 1) review of the fish nutrition research programme of HAKI, 2) research programme for 1982-1985, 3) development of a catfish (Silurus glanis) diet from slaughterhouse wastes, 4) computer-assisted feed formulations for the feed mill, 5) manufacture and testing of larval starter feed, and 6) standard methods for fish nutrition research.

46. **Hastings, W.H.** February 1978. The Hungarian People's Republic - Fish feed technology. Rome (Italy). 35 p. Microfiche no: 39169.
Project: HUN/71/512 - Development of Fish Culture Research. Report HUN/71/512/4.

The report summarizes the activities of the consultant concerning the final installation and operation of a fish feed plant at the Fisheries Research Station in Szarvas, Hungary. In addition, dietary formulations are proposed and presented for carp starter feed, carp yearling feed, market-size carp feed, herbivorous fish fry feed, European catfish starter feed, trout starter feed, and trout developing feed.

INDIA

47. **Chow, K.W.** May 1982. India - Carp nutrition research at the Freshwater Aquaculture Research and Training Centre, Dhauli; establishment of a nutrition laboratory and initiation of a diet development programme for carp polyculture. Rome (Italy). 33 p. Microfiche no: 8226431-E.
Project: IND/75/031 - Intensification of Freshwater Fish Culture and Training. Field Document 4.

As part of a project of the Indian Government, assisted by the UNDP and the FAO, a consultant was engaged with the following terms of reference: 1) to assist in the elaboration of studies on the nutritional requirements of cultivated carps and particularly to start a programme for determining their amino acid requirements and the amino acid profiles of locally available diet ingredients in use; 2) to assist in installation and operation of the feed mill and also to formulate and prepare different types of feeds from locally available ingredients for fry, fingerlings and brood stock of cultivated carps required for experimental and production work in India. The consultant's work, conclusions and recommendations are presented.

48. **Meyers, S.P.** February 1988. Development of coastal aquaculture: A report prepared for the Government of India for Brackish Water Aquaculture Program. Rome (Italy). 35 p.
Project: IND/85/059 - Development of Coastal Aquaculture.

Shrimp (Penaeus monodon) feed manufacturing requirements and ingredient inventory needs and constraints have been identified in terms of pilot farm/hatchery facilities and water-stable diets for scale-up commercial practices. Recommendations and observations include those pertinent to diet formulation as well as optimal utilization of feed under semi-intensive shrimp culture conditions in India. Further emphasis has been placed on careful coordination and scheduling of project goals and recognition of diverse ecological and infrastructure situations relative to establishment of a broadly-based shrimp culture industry in India.

49. **Meyers, S.P.** December 1988. Development of coastal aquaculture: A report prepared for the Government of India Brackish Water Aquaculture Program. Rome (Italy). 25 p.
Project: IND/85/059 - Development of Coastal Aquaculture.

The facilities of the Integrated Fisheries Project (IFP), Cochin, India, and associated support capabilities have been examined for siting of a prototype shrimp feed pilot plant. Recommendations are made for procurement of necessary processing equipment and development of a coordinated schedule for plant installation and operation, including close collaboration with appropriate pilot farm units.

50. **Meyers, S.P.** November 1989. A summary report on participation in the national workshop on brackishwater prawn farming for higher production (23-25 October 1989, Bangalore). Report prepared for Government of India Brackishwater Aquaculture Program. Rome (Italy). 25 p.
Project: IND/85/059 - Development of Coastal Aquaculture.

The report summarizes the group discussions on shrimp feed by the resource persons at a workshop on brackishwater prawn farming for higher production held in Bangalore, India, 23-25 October 1989. In addition, the paper presented by the consultant to the workshop entitled 'Strategy for development of prawn feed for semi-intensive culture under Indian conditions' is annexed to the report.

INDONESIA

51. **Basyari, A.; Tanaka, H.** June 1988. Study on rearing of siganid fishes by some formula feed with different level of crude protein. Report of the seafarming workshop, Bandar Lampung, Indonesia, 28 October - 1 November 1985. Part II - Technical report. Lampung (Indonesia) p. 58-63. Microfiche no: 301365-381.

Project: INS/81/008 - Seafarming Development. General Report 2.

An experiment was conducted using 60 litre aquaria filled with filtered seawater at the Research Institute for Coastal Waters, Karangantu Serang, West Java in August 1981 and May 1982. The aim of the study was to determine the optimum dietary protein requirements of fish by formulating diets with different protein levels. Four diets were formulated containing 58 percent, 46 percent, 35 percent and 29 percent crude protein and fed to Siganus javus (4.79 g average initial body weight) and Siganus canaliculatus (0.49 g average initial body weight). All fish were fed to satiation four times daily over a six-week experimental rearing period. During the experiment water temperature ranged from 28.3 to 29.4°C and pH from 7.70 to 8.02. Siganus javus fed diets containing 35 to 46 percent crude protein displayed the best growth response, whereas Siganus canaliculatus fed the 58% crude protein diet displayed the best growth response.

52. **Chantarasri, S.; Santoso, H.; Hardoto; Yuwono, S.K.** March 1989. Induced spawning and larval rearing of seabass (Lates calcarifer Bloch) in captivity. Lampung (Indonesia). 17 p. Microfiche no: 301385.
Project: INS/81/008 - Seafarming Development. Technical Paper 9.

Seabass (Lates calcarifer) were successfully induced to spawn in captivity by hormonal induction. The hormones used for the trials were HCG plus synthetic hormones (Puberogen). The dosages used were 250 IU HCG plus 50 IU of Puberogen per kg of fish for the first injection and 500 IU HCG plus 100 IU of Puberogen per kg of fish for the second injection at an interval of 24 hours. The fish responded well to the hormones and dosage given. The fish spawned naturally in a 8-ton fibreglass tank within 10 hours after the second injection. The resulting larvae were reared in a 1.7 ton capacity fibreglass circular tank at an initial stocking density of 60-100 larvae per litre. Fish larvae were fed a diet consisting of Tetraselmis chuii, Brachionus, Artemia nauplii, subadult Artemia and minced fish. The third batch produced 600,000 30-day old fry; the average survival rate from yolkfish to 30 days of age being about 45 percent. The results suggested that inducing fish to spawn by hormone manipulation during the off-spawning season may result in the production of a high percentage of unfertilized eggs and abnormal fry. Like other marine fish, seabass fry required a diet containing a high level of the highly unsaturated fatty acids (HUFA) for fast growth and high survival rate.

53. **Djunaidah, I.S.; Kasnadi; Yahya; Sugianto.** August 1990. Fresh anchovies (Stolephorus sp.) as an alternative supplemental feed in P. monodon nursery ponds. Proceedings of Shrimp Culture Industry Workshop, Jepara, Indonesia, 25-28 September 1989, edited by W.G.Yap. Jepara (Indonesia). p. 189-191. Microfiche no: 306101-147.
Project: INS/85/009 - Shrimp Culture Development. Field Document 90/01.

The use of fresh anchovies as nursery feed for Penaeus monodon fry was compared with pellets alone or in combination with pellets. The experiments were conducted in 15x30 m ponds for a period of 4 weeks using PL-5 to PL-8 fry from the BBAP hatchery. Limited number of ponds prevented the testing of all three feeding regimes simultaneously so that those fed fresh anchovies only were conducted at a different time from those fed pellets only and pellets plus fresh anchovies. The results show that in terms of growth the differences were not remarkable since the final length/weight attained were 4.1 cm/432.5 mg; 3.9 cm/406.5 mg; 4.2 cm/395 mg for those fed fresh anchovies, pellets only and pellets plus fresh anchovies, respectively. However, the survival rates were very much higher for those fed only fresh anchovies at 77.5 percent and 85.7 percent against 23.5 percent and 59.6 percent for those fed pellets only and pellets plus fresh anchovies respectively.

54. **Hardjolukito, S.** August 1990. Prospects of developing shrimp feedmills in a depressed market situation. Proceedings of the Shrimp Culture Industry Workshop, Jepara, Indonesia, 25-28 September 1989, edited by W.G.Yap. Jepara (Indonesia). p. 73-76. Microfiche no: 306101-147.
Project: INS/85/009 - Shrimp Culture Development. Field Document 90/01.

The fall of shrimp prices has resulted in a slowdown in the operation of existing tambak and in the planning and development of new tambak projects. In order to overcome this setback, it is necessary to determine: 1) the possibility of using non-intensive culture technology in order to lower production cost since the feed requirement can be lowered by lowering the fry density; and 2) continue to apply intensive culture technology but with the use of locally made feed so as to lower production costs. If the local feed has a quality at least as good as the imported feed, the second alternative, that is to lower production cost by using local feed will provide an opportunity for the local feed industry to seize the Indonesian shrimp feed market. This can happen if the local feedmillers can lower their production cost by using high quality and relatively cheaper local raw materials. Another method which should be attempted is for the feedmillers to band together and import the raw materials as one group. The availability of local feeds with satisfactory quality and a relatively lower price, is expected to provide the necessary "push" for the shrimp growers to continue their production activities as well as their development programme.

55. **Hastings, W.H.** June 1975. Indonesia - Preliminary testing of artificial feeds manufactured from local ingredients for milkfish and shrimps. Rome (Italy). 15 p. Microfiche no: 32599.
Project: INS/72/003 - Brackishwater Shrimp and Milkfish Culture Applied Research and Training.

The report is concerned with the formulation and preparation of feeds for milkfish (Chanos chanos) and shrimp (Penaeus merguiensis) using locally available ingredient sources from the North-Central Java area of Indonesia. Formulations for milkfish and penaeid shrimp are presented together with equipment specifications for the home production of feeds.

56. **Kompiang, I.P.** August 1990. Shrimp feed development. Proceedings of the Shrimp Culture Industry Workshop, Jepara, Indonesia, 25-28 September 1989, edited by W.G. Yap. Jepara (Indonesia). p. 199-202. Microfiche no: 306101-147.
Project: INS/85/009 - Shrimp Culture Development. Field Document 90/01.

In developing shrimp feed, the biological characteristics of the shrimps should be considered and feed formulated accordingly. One of the most important characteristics of the shrimp is its carnivorous feeding habit, which therefore requires the feed to approach the composition of animal organisms, or in other words, to have a high protein level. Shrimp feed for pond use consists of three types, namely, starter, grower and finisher. The levels of the primary nutrients of the three types of feed vary as follows: protein 40-45, 38-40 and 35-38 percent for starter, grower and finisher, respectively; fats: 10-12, 8-10 and 6-8 percent; and carbohydrates: 20-25, 25-30 and 30-35 percent. Aside from the primary nutrients, other essential ingredients are: binder, attractant, vitamin-mineral mix, cholesterol and phospholipids. Methods for formulating shrimp feed are discussed.

57. **Meyers, S.P.** January 1987. Feed formulation, equipment and training, Indonesia. Rome (Italy). 31 p. Microfiche no: 87W00693.
Project: INS/81/008 - Seafarming Development. Field Document 1.

A fully-equipped feed fabrication laboratory for aquatic diet formulation, together with appropriate staff instruction, has been completed at the seafarming site. A diet test programme has been developed with procedures established for ingredient replacement, cost reduction and determination of optimal fish growth and feed usage. The basis for a cooperative information-exchange programme has been established to ensure proper monitoring of test results and ultimate transfer of feeding technology to the village seafarming cooperative level in Indonesia.

58. **Meyers, S.P.** December 1986. Instruction manual on feed equipment use and aquatic feed manufacture. Lampung (Indonesia). 9 p.
Project: INS/81/008 - Seafarming Development. Manual 10.

The manual details the feed manufacturing facilities used for aquatic feed manufacture at the National Seafarming Development Centre in Lampung, Indonesia. Procedures are outlined for the

operation of the feed equipment and laboratory, including the production of an in-house moist pellet, and diet formulations for seabass, grouper and rabbitfish presented.

59. **Meyers, S.P.; Kungvankij, P.; Budihardjo, B.; Kadori, M.** March 1989. Observations on growth and survival of rabbitfish (Siganus canaliculatus) on three formulated diets. Lampung (Indonesia). 11 p.
Project: INS/81/008 - Seafarming Development. Technical Paper 5.

Three semi-moist formulated diets were fed to rabbitfish (Siganus canaliculatus) cultured in nine floating $1m^3$ capacity net cages (150 fish/cage) for 120 days. A completely randomized experimental design with three replications per test diet was followed. Fish were fed to satiation four times daily at 0800, 1400 and 1700 hours. Growth, survival and feed conversion ratio were compared. Statistical analysis indicated that the formulated diet containing 30 percent protein produced the best growth. Feeding rate in relation to size of fish is also presented.

60. **Padlan, P.G.** July 1979. Indonesia - Improvement of milkfish pond production in Japara, Central Java Rome (Italy). 54 p. Microfiche no: 8111131-E.
Project: INS/72/003 - Brackishwater Shrimp and Milkfish Culture Applied Research and Training.

The report presents the results of field trials and laboratory experiments on milkfish (Chanos chanos) production within earthen ponds in Jepara, Central Java. In particular, information is presented on the culture of Lab-Lab and other natural food organisms using a variety of different fertilizers and concerning the use of artificial feeds and substrates for milkfish culture. In addition, the report presents suggested pond management techniques (including stocking and harvesting schedules) and the estimated income and expenditures for the operation of a 1.5 hectare milkfish pond in Jepara, Indonesia.

61. **Pedini, M.; Roskam, R.T.; Langen, D. de.** April 1976. Indonesia - Milkfish culture and pond management. Rome (Italy). 29 p. Microfiche no: 32600.
Project: INS/72/003 - Brackishwater Shrimp and Milkfish Culture Applied Research and Training.

The report is presented under two main headings, the first concerning the natural food preferences of milkfish (Chanos chanos) fry within experimental plastic pools, and the second concerning the management of milkfish ponds, including pond preparation and fertilization.

62. **Tackaert, W.** 1989. Report on consultancy mission on the development of Artemia culture in Indonesia. Jepara (Indonesia). 38 p. Microfiche no: 306191.
Project: INS/85/009 - Shrimp Culture Development. Field Document 89/03.

The report discusses Artemia processing techniques, including recommended cysts drying and storage methods, and the control and determination of cyst quality. Information is also presented on the traditional and industrial salt fields/works visited by the consultant in Indonesia, including existing Artemia production facilities, and recommendations given for a program for the development and optimization of Artemia production within the saltworks visited.

63. **Tacon, A.G.J.** et al. December 1989. The food and feeding of seabass Lates calcarifer, grouper Epinephelus tauvina and rabbitfish Siganus canaliculatus in floating net cages at the National Seafarming Development Centre, Lampung, Indonesia. Lampung (Indonesia). 139 p. Microfiche no: 297833.
Project: INS/81/008 - Seafarming Development. Technical Paper 13.

Four cage feeding trials involving a total of fifteen different dietary feeding regimes were conducted with seabass (Lates calcarifer), grouper (Epinephelus tauvina) and rabbitfish (Siganus canaliculatus) from fingerling to market size over a 100 to 156-day rearing period. Seabass fed frozen fish or a moist pellet displayed the best growth response, with fish ($30/m^3$) growing from an initial weight of 8.9 g and 8.5 g to a final weight of 285.5 g and 257.5 g in 156 days, with a food conversion ratio of 3.77 - 5.10 (dry matter basis 0.96 - 1.30) and 1.89 - 3.20 (dry matter basis 1.15 - 1.95), and with a survival of 93.3 percent and 93.3 percent, respectively. During

the seabass trial the estimated feeding cost/kg fish produced was Rp 1458 - 1964 and Rp 1537 - 2584 for fish fed frozen fish and moist pellet, respectively. Grouper fed frozen fish and moist pellet also displayed the best growth response, with fish (30/m^3) growing from an initial weight of 23.8 g and 25.8 g to a final weight of 471.7 g and 388.7 g in 156 days, with a food conversion ratio of 3.53 - 4.16 (dry matter basis 0.89 - 1.06) and 1.73 - 2.96 (dry matter basis 1.06 - 1.80), and with a survival of 90 percent and 98.3 percent, respectively. During the grouper trial the estimated feeding cost/kg fish produced was Rp 1342 - 1603 and Rp 1382 - 2396 for fish fed frozen fish and moist pellet, respectively. In the case of rabbitfish, the best growth was observed for fish fed a dry in-house crumble containing 31 crude protein; fish (15/m^3) growing from an initial weight of 51.7 g to a final weight of only 110.3 g in 100 days, with a food conversion ratio of 3.48 (dry matter basis 3.08) and estimated feeding cost/kg fish produced of Rp 2349. However, all rabbitfish fed formulated rations displayed marked sexual activity by the end of the feeding trial (62 to 93 percent of the fish yielding milt or eggs on hand stripping). Finally, a fourth cage culture trial was conducted to ascertain the possible use of kerosene pressure lamps and generator powered fluorescent strip lights at night to attract live food fish directly into net cages containing juvenile seabass and grouper, with no use of exogenous dietary feeds. A positive growth response was observed with seabass and to a lesser extent with grouper with increasing net mesh size and decreasing fish stocking density; seabass juveniles (10/m^3) displaying a final mean weight gain of -15.96, 3.63 and 52.04 percent within 1 mm, 13 mm and 19 mm mesh cages over a 63 day culture period, respectively.

64. **Tiensongrusmee, B.; Chantarasri, S.; Budileksono, S.; Yuwono, S.K.; Santoso, H.** 1989. Propagation of seabass, Lates calcarifer in captivity. Lampung (Indonesia). 65p. Microfiche no: 303281.
Project: INS/81/008 - Seafarming Development. Manual 15.

The manual describes the technologies that have been developed and successfully tested at the National Seafarming Development Centre at Hanura, Teluk Betung, Lampung, from 1987-89 regarding the production of seabass (Lates calcarifer) fingerlings. Following an account of the taxonomy and nomenclature of the species, procedures involved in broodstock development and maintenance, sex determination, maturity stages and the selection of mature brooders are detailed. The induction of gonadal maturation, the process of hormone injection, spawning in captivity and factors affecting spawning are outlined. In addition, information is provided on larval rearing, nursery management, disease control, live food production, enrichment of live food, the use of inert food, packing and transport, and sperm preservation.

65. **Yang, W.T.** May 1979. Indonesia - Shrimp culture research. Rome (Italy). 46 p. Microfiche no: 8111133-E.
Project: INS/72/003 - Brackishwater Shrimp and Milkfish Culture Applied Research and Training. Report INS/72/003/7.

This report gives an account of penaeid shrimp culture development work including postlarval production, nursery rearing and pond culture. The post larval culture method was established for Penaeus monodon and P. merguiensis using different types of culture vessels. The total number of postlarvae produced in 1975 was 580,300 and production has increased to over 4 million in 1977; this figure will be rapidly increased in 1978 from induced gonad maturation and spawning. The highest P. monodon postlarvae per brood in a 10m^3 tank was achieved by producing 375,000 with 73 percent survival, and 320,000 with 52 percent survival for P. merguiensis. Mass culture systems of phytoplankton and rotifers were established for larval food organisms. The particulated soybean curd and rotifers were used for the larval diet to substitute for Artemia nauplii. Artemia will still be needed for a better survival rate. Various types of nursery methods were experimented on formulated diet and on natural food in ponds; the optimal nursery stocking densities were determined. A series of pond culture results indicated that interim fish extermination by using 7 ppm derris root was effective. The annual shrimp production in pond projected from preliminary results indicated that 600 kg/ha/year is possible, utilizing natural productivity with fertilization only.

IRAN (ISLAMIC REPUBLIC OF)

66. **Holicky, J.** 1989. Salmonid foods and feeding. Lectures. Training Course in Coldwater Fish Culture, Kalerdasht (Iran), 18 Jan - 3 Mar 1988, edited by D. Edwards. Rome (Italy). p. 77-107. Microfiche no: 290009-017.
Project: TCP/IRA/6755 - Cold Water Fish Culture Training. Field Document 3.

Following an account of the anatomy of the alimentary canal in salmonid fish, details are given of the protein, amino acid and fatty acid requirements and the vitamin and mineral requirements of trout and salmon. Feeding technology and its importance in the operation of an aquaculture venture is discussed in detail, considering the utilization of locally available fish food ingredients, complete diets for fry, fingerlings and market sized fish, fish feed formulation and the influence of feed on health and body composition.

ISRAEL

67. **Meyers, S.P.** April 1976. Israel - Nutrition of marine fish in the region of Elat, Israel. Rome (Italy). 19 p. Microfiche no: 32602.
Project: ISR/73/003 - Development of Marine Farming. Report ISR/73/003/3.

The Mariculture Laboratory facility at Elat, Israel, is unique as a technologically advanced unit, with noteworthy promise in the area of warm water mariculture. Efforts directed toward cultivation of the gilthead bream, Sparus auratus (Denise) have already resulted in artificial spawning and rearing of an F-1 generation, along with development of an initial basal maintenance diet giving significant growth response under a variety of cultural conditions. Formulation of projected dietary preparations for the hatchery, post-hatchery and grow-out phases should permit optimization of survival and growth rates, an understanding of substrate levels required, along with development of a sound basis for subsequent defined diet production and specific nutritional studies. Data generated will be applicable to programme for other species with mariculture application. The variety of approaches, including diverse culture systems (ie. open sea cages, ponds and tanks), complete life cycle analyses and control, and initiation of a diet development/nutrition facility, serve to establish a viable and far-reaching programme. Planning for acceleration of all phases of this integrated effort is warranted and unquestionably will serve as a template for technologically and economically sound mariculture in this region.

68. **Meyers, S.P.** May 1977. Israel - Nutrition of marine fish in the region of Elat, Israel. Rome (Italy). 21 p. Microfiche no: 35777.
Project: ISR/73/003 - Development of Marine Farming. Report ISR/73/003/4.

This report is a follow up of the mission made by the consultant during November 1975 and is concerned with the development, formulation and testing of nutritionally complete artificial diets for marine fish (Sparus auratus) and their larvae and the provision of specifications for the necessary equipment and facilities.

KENYA

69. **Ochumba, P.B.O.; Manyala, J.O.; Achuku, J.O.** October 1988. Fish feed based on silage of Nile perch skeleton and Azolla waterplant. Technical reports. Project Seminar on Improved Utilization of Nile Perch, Kisumu (Kenya), 28-31 March 1988. Rome (Italy). p. 67-74. Microfiche no: 89W01148-E.
Project: GCP/KEN/055/NET - Improved Utilization of Nile Perch.

Since dairy meal is becoming increasingly expensive in Kenya and threatens the fish rearing industry, a systematic study was initiated on the possibility of using aquatic plants and Nile perch silage. The water plants, Azolla niloticus, Lemna perpusilla and Pistia striatotis were tested as a fishmeal substitute for Tilapia zillii and riverine fishes. Low growth rates were achieved in the tilapias. The value of Azolla protein in fish diet is discussed in relation to dietary protein requirement in cultured fish. This study demonstrates that the water plant Azolla niloticus can be used as a complete diet for cultured fish. It is hoped that the project will help provide detailed information on the nutritional value of the water plant Azolla niloticus and its long term susceptibility to various inclusions as a complete feed, and conduct least cost feed formulations to make recommendations as to the maximum inclusion levels.

70. **Tacon, A.G.J.** 1991. Kenya: development of Tilapia feeds. Rome (Italy). 31 p.
Project: KEN/86/027 - Development of Small-Scale Fish Farming in the Lake Basin. Field Document 1.

This report details the results of a consultancy carried out to develop Tilapia (Oreochromis niloticus) feeds for use at the Project's fry production centres and by small-scale farmers in the Lake Basin Region of Kenya. The current feeding strategies employed by the Project and local farmers are critically reviewed and recommendations given for an improved semi-intensive pond feeding strategy using locally available feed resources. Particular attention is given to the improvement of on-farm feed and fertilizer management techniques so as to reduce feed wastage and maximize fish production at minimum cost. Details of the existing and recommended dietary formulations and feeding regimes are fully described.

MADAGASCAR

71. **Autrand, M.** December 1990. Madagascar: plan directeur d'aquaculture des crevettes. Rome (Italy). 159 p.
Project: TCP/MAG/0053 - Plan Directeur d'Aquaculture des Crevettes. Document de Travail 2.

The report looks at the potential development of the marine shrimp aquaculture sector in Madagascar and is presented under the following headings: 1) world shrimp market; 2) shrimp feed production in Madagascar, including dietary nutrient requirements, procedure for manufacture, estimated total feed requirements, ingredient sources and composition, formulations, costings, and importations; 3) prefeasibility studies; 4) investment climate and potential; 5) recommended strategy for the development of the shrimp farming sector in Madagascar.

72. **Autrand, M.** May 1991. Madagascar: essais d'elevage de crevettes de mer. Rome (Italy). 42 p.
Project: MAG/88/006 - Ferme Pilote d'Aquaculture des Crevettes. Document de Travail.

The report is concerned with a biotechnical and economic evaluation of the shrimp culture practices employed at the project's pilot shrimp farm in Madagascar. Recommendations are given for the follow up of the project, including research activities related to the production of local compound shrimp feeds.

73. **Chim, L.** June 1990. Elevage de crevettes de mer de Nosy-Be. Rome (Italy). 52 p. Microfiche no: 303291.
Project: MAG/88/006 - Ferme Pilote de l'Aquaculture des Crevettes. Document de Travail.

The report is concerned with an analysis of the fertilization and feeding practices employed at the Nosy-Be pilot shrimp farm in Madagascar for the culture of Penaeus indicus and Penaeus monodon. Recommendations are given for the formulation and in-house manufacture of compound shrimp feeds using locally available and imported feed materials.

74. **Cuzon, G.** April 1989. Rapport de mission a Madagascar pour le projet Ferme Pilote d'Aquaculture des Crevettes. Rome (Italy). 18 p. Microfiche no: 297255.
Project: MAG/88/006 - Ferme Pilote d'Aquaculture des Crevettes. Document de Travail.

The report summarizes the activities of the consultant concerning the formulation and manufacture of compound feeds for Penaeus monodon and Penaeus indicus at the project's pilot shrimp farm in Madagascar.

75. **Nugent, C.** July 1989. Introduction de l'aquaculture au lac Itasy. Rome (Italy). 47 p. Microfiche no: 291699.
Project: MAG/86/005 - Developpement Agricole Integre de la Region du Lac Itasy. Document de Travail.

The findings are presented of a mission conducted in Madagascar in order to investigate the possibility of introducing aquaculture in the region of Lake Itasy, in particular examining cage or enclosure culture systems. Three species of fish were studied: Tilapia nilotica, Cyprinus carpio and Tilapia rendalli. Recommendations are included for fish feed formulation and feeding trials and for a research project at Kianjasoa.

MALAWI

76. **Pruginin, Y.; Arad, A.** July 1977. Fish farming in Malawi. Rome (Italy). 28 p. Microfiche no: 36424.
Project: MLW/71/516 - Promotion of Integrated Fishery Development. Report MLW/71/516/10.

The paper presents information concerning the feasibility of commercial fish farming in Malawi. Fish production (Sarotherodon mossambicus and Tilapia rendalli) was reported to be increased from 130 kg/hectare/year with no feeding to 3,000 kg/hectare/year with fertilization and feeding. The results of production trials using a variety of different feed rations (Lucaena leucocephala leaves, maize bran, maize germ and cottonseed cake) are presented.

MALAYSIA

77. FAO. 1984. Coastal aquaculture development, Malaysia - Selected papers prepared during the activities of the project. Rome (Italy). 281 p. Microfiche no: 85W01114.
Project: MAL/77/008 - Coastal Aquaculture Demonstration and Training. Field Document 2.

The report presents 13 papers prepared during the activities of the Coastal Aquaculture Demonstration and Training Project, including 1) diet development for sea bass, grouper and penaeid shrimp culture in Malaysia, 2) geochemistry and microbiology of coastal aquaculture demonstration and training project, Gelang Patah, Johore Bahru, Malaysia, 3) feed formulation for penaeid shrimp, sea bass, grouper and rabbitfish culture in Malaysia, 4) report to the Food and Agriculture Organization on a consultancy mission to the Fisheries Research Institute, Glugor, Penang, Malaysia (live food production), 5) comparative study of tidal and pumped water supply for brackishwater aquaculture ponds in Malaysia, 6) the contribution of primary production and meiofauna to food chains based on bacteria in penaeid prawn aquaculture ponds, 7) use of screens and boards in water management for tidal ponds, 8) survey of wild fish fry and their suitability for aquaculture in Tanjung Adang, Johor, Malaysia, 9) experiences in establishing vegetation on acid sulphate pond dikes, 10) cleaning interior canals of brackishwater ponds, 11) aeration and water circulation in brackishwater aquaculture ponds, 12) recommendations for construction and management of brackishwater aquaculture ponds in areas with acid sulphate soils, and 13) fabrication of feed suitable for smallholder aquaculture.

78. Chow, K.W. 1984. Diet development for sea bass, grouper and penaeid shrimp culture in Malaysia. (A survey of fish feeds and initiation of programme). Coastal aquaculture development, Malaysia. Rome (Italy). p. 1-18. Microfiche no: 85W01114.
Project: MAL/77/008 - Coastal Aquaculture Demonstration and Training. Field Document 2.

Four species present in the coastal waters of Malaysia were selected for study with respect to feeding requirements under intensive culture conditions: Penaeus, Lates calcarifer, Epinephelus tauvina and Siganus. Primary objectives were to develop diets providing high economic return and to develop knowledge on the interchangeability of raw materials to ensure continued economic operation during periods of shortages of certain key ingredients. Observations and work completed are summarized under the following headings: 1) survey of feed raw materials; 2) survey of the feed milling industry; and 3) fish diet development of Gelang Patah. Conclusions and recommendations are included.

79. Chow, K.W. 1984. Artificial diets for Sea Bass, Macrobrachium and Tiger shrimp (consultant's report). Rome (Italy). 19 p.
Project: MAL/79/018 - Institutional Support for MAJUIKAN Aquaculture Development.

The report describes the work carried out by the consultant on artificial diet development during a one-month period for the three species mentioned. The work included: formulation, preparation, evaluation and testing of a large number of diets for all life stages of the species; and design and construction of equipment used in feeding experiments and in diet preparation.

80. Hassan, I.A.; Sayuthi, S.; Chiam, C.S. 1984. Fabrication of feed suitable for smallholder aquaculture. Coastal aquaculture development, Malaysia. Rome (Italy). p. 261-278. Microfiche no: 85W01114.
Project: MAL/77/008 - Coastal Aquaculture Demonstration and Training. Field Document 2.

This report reviews basic techniques for the preparation of pelleted feed which are considered suitable for small-scale farmers (individual or group basis). Experiments carried out on fish nutrition are also discussed. Formulated feed are given to shrimp (Penaeus monodon), sea bass, grouper and rabbitfish.

81. James, C.M. 1984. Report to the Food and Agriculture Organization on a consultancy mission to the Fisheries Research Institute, Glugor, Penang, Malaysia, 1-30 September 1982 (live feed production for aquaculture). Coastal aquaculture development, Malaysia. Rome (Italy). p. 79-118. Microfiche no: 85W01114.
Project: MAL/77/008 - Coastal Aquaculture Demonstration and Training. Field Document 2.

The consultancy programme regarding live food production for aquaculture had the following objectives: 1) culture of unicellular algae, marine yeast, rotifers, copepods and adult Artemia as live foods for larval shrimp and fish; 2) provide advice on the modification of existing culture facilities and construction of new ones if necessary; and 3) provide training for national staff through the practice of culture operations.

82. Kanazawa, A. 1984. Feed formulation for penaeid shrimp, sea bass, grouper and rabbitfish culture in Malaysia. Coastal aquaculture development, Malaysia. Rome (Italy). p. 61-78. Microfiche no: 85W01114.
Project: MAL/77/008 - Coastal Aquaculture Demonstration and Training. Field Document 2.

The report summarizes a consultancy undertaken to develop feed formulations for penaeid shrimp, sea bass, grouper and rabbitfish. Diets formulated are detailed and a programme of research on diet development for the local fish species presented.

83. Moriarty, D.J.W.; Cook, H.L.; Hassan, R.; Thanabal, M. October 1984. The contribution of primary production and meiofauna to food chains based on bacteria in penaeid prawn aquaculture ponds. Coastal aquaculture development, Malaysia. Rome (Italy). p. 161-181. Microfiche no: 85W01114.

Project: MAL/77/008 - Coastal Aquaculture Demonstration and Training. Field Document 2.

The results of work undertaken regarding the role of bacteria and meiofauna in prawn ponds in Malaysia are presented. Respiration, primary production and nutrient concentrations were investigated. Bacteria productivity is high in the water column and sediments, and appears to result from food pellets thrown into the ponds; meiofauna act as a link between the bacteria and prawns. The relationships between bacteria and meiofauna are discussed in detail.

84. **New, M.B.** 1986. Feeds for seabass and tiger prawns, Malaysia. Rome (Italy). 64 p. Microfiche no: 86W01481.
Project: MAL/79/018 - Institutional Support for MAJUIKAN Aquaculture Development. Field Document 2.

During a 2-month feeds consultancy in Malaysia in November-December 1985, tutorials in fish/shrimp nutrition, demonstration of feed manufacture, and two short term feeding trials were carried out. Formulations for an improved vitamin mix for shrimp, seabass, grouper and tilapia were provided. The artificial diet for juvenile seabass was tested and proved to give good growth rate, survival rate and apparent food conversion ratio and was cheaper to use than the filleted trash fish normally used for young fingerlings. A trial using the new formulated post-larval diet for shrimp Penaeus monodon post-larvae was conducted. The new feed gave nearly twice the survival rate and a better growth rate than the micro-encapsulated egg-based diet previously used. The new feed has a feeding cost only 13 percent of that of the micro-encapsulated diet. The report also contains a series of recommendations on future feed development, feed manufacture, experimental protocol and training.

85. **Ruangpanit, N.** March 1986. Report to the Government of Malaysia on training in hatchery techniques. Rome (Italy). 31 p. Microfiche no: 86W01221.
Project: GCP/MAL/009/CAN - Besut Integrated Fisheries Development.

The report describes project activities regarding fry production of marine and freshwater fish and prawns at the Tanjong Demong Hatchery and the development of aquaculture in Besut with particular reference to the species Lates calcarifer and Penaeus monodon. The report is presented under the following headings: 1) training on the mass culture of food organisms, including Tetraselmis and rotifer mass culture; 2) transfer and conditioning of Lates calcarifer broodstock for breeding purposes; 3) training for finfish hatcheries; 4) nursing seabass fry up to fingerling size for cage culture, including feeds and feeding; 5) finfish hatchery design and specification; and 6) training for marine shrimp hatchery.

MEXICO

86. **Hughes, D.G.** July 1991. Aspectos practicos en la alimentacion de los camarones peneidos. Sinaloa (Mexico). 24 p.
Project: MEX/87/018 - Fomento y Desarrollo de la Acuicultura y Maricultura. Documento Tecnico.

The report is concerned with the practical aspects of feeding penaeid shrimp and is presented under the following headings: 1) culture operations, including larval production and grow-out; 2) nutritional requirements, including proteins and amino acids, energy, lipids, carbohydrates, vitamins and minerals; 3) ingredients and feeding, including natural food organisms and ingestion; and 4) practical feeds, including dietary formulations and feeding levels.

87. **Hughes, D.G. (et al.).** July 1991. Diagnostico integral de las granjas acuicolas camaroneras en el estado de Sinaloa. Sinaloa (Mexico). 297 p.
Project: MEX/87/018 - Fomento y Desarrollo de la Acuicultura y Maricultura. Documento de Campo.

The report reviews the status of the shrimp farms operating in the state of Sinaloa, Mexico. Within the technical part of the report a brief analysis is made of the fertilizer, feed and feeding regimes employed by the farmers in the state.

MOZAMBIQUE

88. **Martinez Palacios, C.A.** November 1991. Reporte de la mision de nutricion/alimentacion. Rome (Italy). 87 p.
Project: MOZ/86/033 - Pilot Project for Coastal Shrimp Culture.

The report summarizes the activities of the consultant concerning the development of compound shrimp feeds for use at the project's pilot shrimp farm. On the basis of a survey of available feed ingredient sources, dietary formulations for shrimp are presented and guidelines given for the manufacture of laboratory feeds and for on-farm feed management.

PAKISTAN

89. **Kausar, R.** January 1982. Review on recycling of animal wastes as a source of nutrients for freshwater fish culture within an integrated livestock system. Islamabad (Pakistan). 54 p. Microfiche no: 8330781-E.
Project: PAK/80/019 - Coordinated National Programme for Livestock Feed Resources and Nutrition.

The review describes in a comprehensive manner the state of knowledge in the utilization of animal wastes and their feeding to fish. A special attention is being paid to the mechanism of livestock waste recycling and an integrated approach involving livestock species whose manure can be utilized as a sole donor of nutrients for fish farming. The integration describes fish species consuming manures directly or through zooplankton, phytoplankton and macrophytes. A special chapter is allocated to feeding systems and procedures in nursery ponds using organic and chemical fertilizers as main sources of nutrients. The suitability of catfish for tropical and subtropical fish farming is exemplified with particular respect to countries of Southeast Asia. The results of an impressive research carried out in the sub-tropical part of USA are also presented. A chapter on carp farming emphasises those specific areas which involve feeding of livestock wastes as a sole source of nutrients for fish via various eco-systems. The main objectives of integrated fish farming are highlighted with special reference to Pakistan.

90. **Rajbanshi, K.G.** January 1988. Field report - aquaculture considerations. Rome (Italy). 11 p.
Project: TCP/PAK/6657 - Fisheries Development in Reservoirs. Field Document 3.

The report summarizes the activities of the aquaculture specialist during a one month consultancy, including 1) observations concerning a visit to the Fish Hatchery and Nursing Unit, Mangla, 2) hatchery planning, 3) cage fish culture, and 4) supplementary feeding, including availability of fish feed, and recommended dietary formulations and feeding techniques for local freshwater fish species.

PAPUA NEW GUINEA

91. **Pitt, R.M.** 1986. Carp cultivation and the Highlands Aquaculture Development Centre, Aiyura, Papua New Guinea. Rome (Italy). 112 p. Microfiche no: 86W01379.
Project: TCP/PNG/4503 - Re-establishment of Carp Fishing. Field Document 1.

Details are given of project activities which concerned carp (Cyprinus carpio) culture techniques and hatchery management in Papua New Guinea, and the preparation of a training program in carp culture techniques and hatchery management, including pond fertilization and feeding. Proposals for improving the Highlands Aquaculture Development Centre are also detailed.

92. **Tacon, A.G.J.** July 1986. Development of carp feeds, Papua New Guinea. Rome (Italy). 49 p. Microfiche no: 86W01933.
Project: TCP/PNG/4503 - Re-establishment of Carp Fishing. Field Document 3.

This report details the results of a consultancy carried out to develop carp (Cyprinus carpio) feed using locally available ingredients for use at the Aiyura carp station, administered by the Fisheries Division of the Department of Primary Industry. Baseline data on the agricultural feed resources of Papua New Guinea are summarized, and national agricultural and industrial by-products identified for potential use as carp feed at the Aiyura carp station and surrounding highland village fish ponds. The principle by-products identified are coffee pulp, pasture and arable crop waste, barley mill sweepings, livestock manure, copra cake and wheat mill run. On the basis of the feed resources available, a low-cost semi-intensive feeding strategy, using a combination of organic fertilization and supplementary feeding, is recommended for use at the Aiyura carp station and village fish ponds, and is fully described.

REPUBLIC OF KOREA

93. **Gauchon, M.J.; Gil, N.; John, B.C.; Kim, I.-B.** October 1973. Water storage and fish culture. Rome (Italy). 72 p. Microfiche no: 43842.
Project: ROK/67/522 - Upland Development and Watershed Management. Working Paper 8.

The report presents information on the pond culture of common carp (Cyprinus carpio), grass carp (Ctenopharyngodon idella), silver carp (Hypophthalmichthys molitrix) and bighead carp (Aristichthys nobilis) in Korea, including recommended pond management and feeding practices.

SAUDI ARABIA

94. **Cuzon, G.** September 1985. Development of a small-scale feed mill and feed formulations for warm-water finfishes at the Fish Farming Centre, Jeddah, Saudi Arabia - Report to the Government. Rome (Italy). 19 p. Microfiche no: 85W03147.
Project: UTFN/SAU/010/SAU - Fish Farming Centre.

The report presents information on feed ingredient availability within Saudi Arabia and the formulation and testing of experimental diets for Tilapia spilurus and Siganus rivulatus at the fish farming centre in Jeddah. Recommendations on equipment for fish feed manufacture and concerning experimental protocol are also discussed.

95. **Shehadeh, Z.H.** 1991. Report to the Government of Saudi Arabia: review and assessment of research activities and progress during phase I and II and the proposed programme of work and budget for phase III. Rome (Italy). 250 p. (in press)
Project: UTFN/SAU/010/SAU - Fish Farming Centre.

The report is presented under the following headings, 1) assessment of work and progress (1981-1990), 3) aquaculture survey, 4) review of proposed plan of work for phase III, and 5) recommended programme of work and priorities for phase III. In addition to general information on the past and proposed future aquaculture activities of the Fish farming Centre and within the Kingdom of Saudi Arabia, information is provided concerning the research activities conducted by the project on the food and feeding of Tilapia (Oreochromis spilurus), rabbitfish (Siganus rivulatus) and shrimp (Penaeus monodon/P. indicus), including live food production techniques.

THAILAND

96. **FAO.** 1986. Development of micro-algae (Spirulina) production, Thailand. Rome (Italy). 5 p. Microfiche no: 86M01090.
Project: TCP/THA/2307 - Development of Micro-algae (Spirulina) Production.

The paper summarizes the activities and results of a project concerning micro-algae (Spirulina) production in Thailand, including consultancies, study tours and preliminary experiments conducted.

97. **Boonyaratpalin, M.; Taechajunta, K.; Vorasayan, P.; Suksucheep, V.** 1980. Shrimp nutrition in Japan. A study tour report. Rome (Italy). 13 p. Microfiche no: 8113201-E.
Project: THA/75/008 - Programme for the Expansion of Freshwater Prawn Farming. Working Paper 80/21.

Shrimp nutrition in Japan is discussed under the following headings, 1) shrimp culture in Japan, 2) nutrient requirements of postlarval Penaeus japonicus, 3) dry packing, 4) larval feeds, and 5) culture of Macrobrachium.

98. **Dhamrongrat, S.; Kasesunchi, P.** 1981. Feeds for catfish (Clarias batrachus Linn.) fry. Bangkok (Thailand). 14 p. Microfiche no: 84X00655.
Project: THA/75/012 - Programme for the Development of Pond Management Techniques and Disease Control. Working Paper 11.

Boiled rice bran, Moina sp., boiled tilapia flesh, fresh chub mackerel viscera and fresh pig blood were tested as feeds for raising fry of pla duk dan (Clarias batrachus). The fry, averaging 0.233 to 0.316 g, were reared in pottery water jars containing five litres of water that was exchanged every two days. The feeds were applied at a rate of 5 percent body weight/day. At the end of the 65-day trials the best gains, ranging from 0.51 to 0.82 grams/fish, were attained with the Moina, tilapia and mackerel feeds. Average weight gains with the rice bran and pig blood feeds were 0.35 and 0.38 grams/fish, respectively. Survival was relatively high in all cases, ranging from 71 to 92 percent. The highest net production in each trial was with mackerel feed, being the equivalent of 10.6 kg/m^3 in trial No.1 and 6.5 kg/m^3 in trial No.2; the corresponding values for tilapia feed were 8.1 and 6.0 kg/m^3 while net production on Moina feed in trial 1 was 9.9 kg/m^3. The reasons for the differences in growth and production results observed for the same treatment in different trials was not known.

99. **Halver, J.E.** 1990. Fish nutrition consultancy report (1 June to 15 July 1989). Rome (Italy). 35 p.
Project: THA/87/004 - Fish Nutrition and Aquaculture Diets.

The report is concerned with the development of a diet research programme for Clarias and Pangasius catfish, and in particular: 1) the demonstration of vitamin and enzyme analysis techniques, 2) the design of fish nutrition experiments relating particularly to vitamins and enzymes, and 3) advise on formulating appropriate diets for catfish and other finfish. The report also contains information on in-service training activities and equipment status for nutrient analysis within the nutrition laboratory of the project.

100. **Halver, J.E.** 1990. Fish nutrition consultancy report (6 July to 26 August 1990). Rome (Italy). 33 p.
Project: THA/89/003 - Fish Nutrition and Aquaculture Diets.

The report summarizes the activities of the consultant concerning the demonstration of fatty acid profile analysis and for the development of a amino acid and protein requirement study programme for Pangasius catfish and Penaeus monodon at the National Inland Fisheries Institute in Bangkok. In addition, information is presented on the in-service training activities of the project, procedures

for vitamin C analysis, and literature reviews concerning lipid, protein and amino acid nutrition in crustaceans annexed to the report.

101. **Halver, J.E.** 1991. Fish nutrition consultancy report (12 September to 4 November, 1991). Seattle (USA). 84 p.
Project: THA/89/003 - Fish Nutrition and Aquaculture Diets.

The report summarizes the activities of the consultant concerning the formulation and initiation of a research programme on the development of optimal feeds for freshwater prawns and marine shrimp. An evaluation of the progress of the project to date is given, and information presented on the lipid research programme and the vitamin requirement and sources research programme at NIFI (National Inland Fisheries Institute). Annexes are attached to the report concerning 1) proforma for lipid research programme at NIFI, 2) protocols for feed C assays and analyses, 3) vitamin requirements research proforma, 4) protocol for tissue sample preparation, 5) dietary formulations for extruded catfish feed, 6) laboratory equipment needs and supplies, 7) project extension justification, 8) dietary mineral requirements of fish and shrimp, 9) ASTOS (ascorbic acid, C2) in rainbow trout in seawater, and 10) feed mix record sheet.

102. **Hardy, R.W.** 1990. Fish nutrition consultancy report (1 October to 30 November 1990). Rome (Italy). 51 p.
Project: THA/89/003 - Fish Nutrition and Aquaculture Diets.

The report describes the activities of the consultant concerning the in-house training of government staff on methods for the analysis of amino acids and vitamin C in fish fish feeds and fish tissues. In addition information is presented on the use of computers for feed formulation, and concerning the planning and implementation of future research programmes on diet development. A report is also made of a workshop attended by the consultant in Pusan (Republic of Korea) on fish health management and a copy of his paper presentation to the workshop is annexed to the report.

103. **Hardy, R.W.** December 1991. Fish nutrition consultancy report (27 September to 5 December 1991). 23 p.
Project: THA/89/003 - Fish Nutrition and Aquaculture Diets.

The report summarizes the activities of the consultant from 27 September to 5 December 1991 and is presented under the following main headings: 1) terms of reference, 2) amino acid analysis by HPLC, 3) ascorbic acid analysis by HPLC, 4) gas chromatography operation, 5) computer formulation of feeds, 6) fish nutrition short course at NIFI (National Inland Fisheries Institute), 7) evaluation of equipment and facilities at NIFI, 8) future fish nutrition research at NIFI, 9) general nutrition consultancy, and 10) recommendations.

104. **Kongkeo, H.** 1990. Fish feed technologist's (consultant) report (1 January to 28 February 1990). Rome (Italy). 29 p.
Project: THA/89/003 - Fish Nutrition and Aquaculture Diets.

The report summarizes the activities of the consultant concerning the organization of research and training programmes in shrimp feed management and concerning the development of economic marine shrimp and fish feeds by the Project. In addition, a training manual on shrimp feed management is presented, together with recommended dietary formulations for marine shrimp, Asian seabass and grouper.

105. **Nagai, Y.** 1990. Fish feed technology consultancy report (1 September to 31 October 1990). Rome (Italy). 29 p.
Project: THA/89/003 - Fish Nutrition and Aquaculture Diets.

The report summarizes the activities of the consultant concerning the development of compound feeds for marine fish and shrimp, including suggested feed formulations and experimental feed manufacturing protocols. In addition, the report presents information concerning the dietary

vitamin requirements of Yellowtail and concerning the production and feeding of marine finfish and shrimp in Japan.

106. **New, M.B.** 1980. The diet of prawns. Rome (Italy). 21 p. Microfiche no: 8113185-E.
Project: THA/75/008 - Programme for the Expansion of Freshwater Prawn Farming. Working Paper 80/12.

The paper is divided into two parts or lectures. Lecture 1 is concerned with what is known about freshwater prawn nutrition, including larval and postlarval nutrition. Lecture 2 is concerned with what feeds are used in commercial prawn production, including larval and postlarval feeds. Examples of dietary feeding regimes and diet formulations are presented.

107. **New, M.B.** 1980. Bay Brand Artemia (an account of a 1971 visit to San Francisco). Rome (Italy). 5 p. Microfiche no: 8113187-E.
Project: THA/75/008 - Programme for the Expansion of Freshwater Prawn Farming. Working Paper 80/14.

The paper describes the Artemia harvesting and processing procedures employed by "Bay Brand" in San Francisco.

108. **New, M.B.** 1980. Notes on the crustacean nutrition papers presented at the 11th Annual Meeting of the World Mariculture Society, New Orleans, March 5-9, 1980. Rome (Italy). 8 p. Microfiche no: 8113189-E.
Project: THA/75/008 - Programme for the Expansion of Freshwater Prawn Farming. Working Paper 80/15.

The paper presents the full references and author addresses of the papers presented at the 11th Annual Meeting of the World Mariculture Society, together with summary notes of papers presented.

109. **New, M.B.; Boonyaratpalin, M.; Vorasayan, P.; Intarapichate, S.** 1980. An assessment of the performance of Macrobrachium rosenbergii fed simple non-vitamin-supplemented pelleted diets. Rome (Italy). 27 p. Microfiche no: 8113191-E.
Project: THA/75/008 - Programme for the Expansion of Freshwater Prawn Farming. Working Paper 80/16.

The paper describes and discusses the results of two feeding trials conducted with juvenile freshwater prawns fed formulated diets containing different protein levels (15, 25 and 35 percent) or a chicken starter crumble either in earthen ponds or outdoor concrete ponds in Thailand. Although there was no significant difference in the mean final body weight of prawns fed the four diets in concrete ponds, the higher protein diets performed better than the lower protein experimental rations in earthen ponds. The lack of a dietary vitamin or mineral supplement in the diets tested did not appear to have any deleterious effect on the prawns cultured in concrete ponds.

110. **Sorgeloos, P.** 1978. The culture and use of brine shrimp, Artemia salina, as food for hatchery-raised larval prawns, shrimps and fish in Southeast Asia. Rome (Italy). 50 p. Microfiche no: 8113167-E.
Project: THA/75/008 - Programme for the Expansion of Freshwater Prawn Farming. Working Paper 78/3.

This paper is based on consultancy tours made in the Philippines, Thailand and Indonesia in Southeast Asia. These extended in intermittent periods from June 1976 to November 1978. Four visits were made to the Philippines where work was mainly done with the Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC) and in Thailand and Indonesia with ongoing FAO/UNDP projects. The work in these countries varied from assistance on the effective use of acquired Artemia salina in fish hatcheries to raising it in pilot-scale raceways and also initiation of trial cultures in natural saline earth ponds for the production of cysts.

111. **Srisuwantach, V.; Soungchomphan, R.; Sitasit, P.** 1981. Comparison of the effects of trash fish and pelleted diets in Clarias grow-out operations. Bangkok (Thailand). 25 p. Microfiche no: 84X00657.
Project: THA/75/012 - Programme for the Development of Pond Management Techniques and Disease Control. Working Paper 15.

The environmental characteristics of four ponds and the production performance of Clarias in the ponds was investigated in response to the application of two feeds from November 1980 to March 1981. Each of the 800 m^2 ponds was stocked with 20,000 fry, averaging 6.8 g; trash fish was applied in two ponds and a pelleted diet in the other two. After 5 months 26 percent of the Clarias fed on trash fish survived; they had attained an average weight of 94.2 g at the rate of 0.61 g/day. The survival rate of Clarias fed a pelleted diet was 22 percent; the fish reached an average weight of 86.2 g in 5 months at the rate of 0.55 g/day. Corresponding net yields for the period were 0.434 and 0.279 kg/m^2. Water quality conditions were comparable in each pond throughout the grow-out period with the exception that BOD values in ponds fed on trash fish averaged 8.4 g $O2/m^3$/day as opposed to 6.9 g $02/m^3$/day in ponds were pelleted food was used. Chemical adversities were not as pronounced as recorded in similar culture operations. The difference was attributed to relative low stocking densities and to frequent water exchanges in the study ponds. The high mortality, slow growth and outbreaks of disease was related to the relatively low water temperatures and the amplitude of change which occurred through the culture period.

112. **Taechajunta, K.; Sitasit, P.** 1981. Assessment of a vitamin and mineral premix in an artificial feed for pla duk oui (Clarias macrocephalus) fry. Bangkok (Thailand). 10 p. Microfiche no: 84X00656.
Project: THA/75/012 - Programme for the Development of Pond Management Techniques and Disease Control. Working Paper 12.

Clarias macrocephalus fry were reared on two artificial feeds, one with a vitamin and mineral premix and the other without. The fry, 15 day old fish averaging 0.2 grams each, were stocked at a density of 1,000/m^2 in fibre glass tanks and were fed at 5 percent body weight per day. At the end of the 33-day feeding trial fish survival within lots fed on food containing the premix was 79 percent and the average fish size was 0.65 g. By contrast, survival within the opposing treatment was 35.18 percent and the average fish size was 0.48 g. Cost estimates indicated that the diet containing the premix could be prepared for about Bhat 10 (US$ 0.50)/kg and that Bhat 1 (US$ 0.05) worth of feed would be required to feed 100 fry for 30 days.

113. **Tunsutapanich, A.** 1979. An improved technique for decapsulation and preservation of Artemia cysts (brine shrimp eggs) developed at the Chachoengsao Fisheries Station. Rome (Italy). 6 p. Microfiche no: 8113173-E.
Project: THA/75/008 - Programme for the Expansion of Freshwater Prawn Farming. Working Paper 79/6.

Decapsulation of brine shrimp eggs was originally carried out with sodium hydroxide and sodium hypochlorite at the Chacheongsao Fisheries Station, Thailand. The cost of decapsulation by that technique was estimated at Bhat 300/kg of brine shrimp eggs. A modified technique has been developed whereby decapsulation is conducted by using calcium oxide and calcium hypochlorite as stimulating agents. Promising results were achieved with the same degree of success as with the former technique. However, the latest technique is better because the cost of decapsulation can be reduced from Bhat 300/kg to only Bhat 18/kg of brine shrimp eggs.

114. **Tunsutapanich, A.** 1979. Cysts production of Artemia salina in salt ponds in Thailand. Rome (Italy). 15 p. Microfiche no: 8113179-E.
Project: THA/75/008 - Programme for the Expansion of Freshwater Prawn Farming. Working Paper 80/9.

The paper deals with the value of Artemia production and presents the techniques used and results of experiments on cyst production in Thai salt ponds.

115. **Vos, J.** February 1979. Brine shrimp (Artemia salina) inoculation in tropical salt ponds: a preliminary guide for use in Thailand. Rome (Italy). 18 p. Microfiche no: 8113169-E.
Project: THA/75/008 - Programme for the Expansion of Freshwater Prawn Farming. Working Paper 79/4.

The paper presents information under the following headings: 1) biology of Artemia in connection with cyst production, 2) strain selection, 3) pond selection and preparation, 4) preparation of the inoculum, 5) inoculation, 6) observations and activities during farming, 7) cyst and adult harvesting, 8) processing of produced cysts and adults, and 8) previous inoculations.

VIET NAM

116. **FAO.** 1990. Compte rendu final du projet developpement de la culture d'Artemia pour son utilisation en aquiculture, Viet Nam. Rome (Italy). 10 p. Microfiche no: 302723.
Project: TCP/VIE/6656 - Development of Artemia Culture for Aquaculture Use.

The report summarizes the results of the project concerning the culture of Artemia salina in Viet Nam. Information is presented on the results and achievements of the project on training, experimental research facilities, Artemia cyst production, and use of Artemia as a larval feed for freshwater prawns (Macrobrachium rosenbergii) and penaeid shrimps (Penaeus indicus, P. merguiensis).

117. **Meeusen, A.** 1986. Consolidation du Programme Elevages Associes, Viet Nam. L'integration des cultures fourrageres et de la production animale a la pisciculture intensive. Rome (Italy). 72 p. Microfiche no: 86M01957.
Project: TCP/VIE/2202 - Developpement de l'Aquaculture dans les Lacs Artificiels de Dong Mo et de Suoi Hai dans la Region d'Hanoi.

The report summarizes the activities of the project concerning the integration of agricultural crop and farm animal production systems with the culture of carp and Tilapia in ponds and cages.

ZAMBIA

118. **New, M.B.** February 1988. Demonstration of the manufacture and use of simple compounded feeds for semi-intensive Tilapia culture in Zambia. Rome (Italy). 29 p. Microfiche no: 88W01067.
Project: GCP/ZAM/038/NET - Fish Culture Development in Zambia.

Project activities regarding mixed feeds for tilapia production in Zambia are described. Various alternative formulations were examined. Recommendations are given for suitable feed manufacturing equipment for the tilapia project farms, together with guidelines for feeding rate and frequency.

II. REPORTS FROM REGIONAL PROJECTS

NEAR EAST

REGIONAL FISHERY SURVEY AND DEVELOPMENT

119. **Coche, A.G.; Cuzon, G.; Lichatowich, T.** July 1979. Mariculture development in Bahrain. Report of a feasibility mission. Rome (Italy). 59 p. Microfiche no: 8001069-E.
Project: RAB/71/278 - Regional Fishery Survey and Development. Report RAB/71/278/6.

The report is presented under the following headings, 1) status of fish production, marketing and demand, 2) background of aquaculture development (including fish feeds: availability of ingredients and preparation of compounded feeds for rabbitfish (Siganus canaliculatus) and shrimp (Penaeus semisulcatus), 3) proposed development programme, and 4) external assistance requirements.

MEDITERRANEAN

REGIONAL MEDITERRANEAN AQUACULTURE DEVELOPMENT

120. **Mediterranean Regional Aquaculture Project (MEDRAP).** May 1986. Technics used for intensive rearing and alimentation of fish and shellfish (Lectures given at the 6th Training session, 3-15 June 1985) Villanova di Motta di Livenza, Italy (and Rovinj, Yugoslavia). Tunis (Tunisia). v. 1-2. Microfiche no: 86X01803.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

The report of the 6th MEDRAP Training Session is divided into two volumes: Volume 1 contains general information regarding the meeting and papers presented during the session on water management and aquaculture engineering, including 1) water, a rearing environment and its management in aquaculture, 2) the control of environmental factors in intensive marine aquaculture, 3) technological and energetic aspects of water management for intensive aquaculture, 4) pumping water for marine aquaculture, and 5) rearing structures for aquaculture. Volume 2 contains the following papers: 6) coastal fishculture in the Upper Adriatic, 7) intensive rearing of sea-bass (Dicentrarchus labrax) and gilthead sea-bream (Sparus auratus) in raceways: Biological and technological aspects of fattening, 8) intensive fishculture, 9) intensive rearing of eel, 10) intensive rearing of mullet, 11) trophic community correlations in fertilized ponds for the commercial culture of the Kuruma prawn Penaeus japonicus in the North Adriatic Sea (North East coast of Italy), 12) new rearing techniques and larvae quality improvements in sea-bass (Dicentrarchus labrax) hatcheries, 13) post larvae production of P. japonicus: increase in productivity by modifying the feed sequence, 14) industrial manufacture of compound food for marine species, 15) feeding principles for marine fish under intensive culture, 16) marine fish feed, 17) quality control of feed in pisciculture, and 18) pathological aspects of intensive rearing.

121. **Amerio, M.** May 1986. Quality control of feed in pisciculture. Technics used for intensive rearing and alimentation of fish and shellfish. Lectures given at the 6th Training session, 3-15 June 1985, Villanova di Motta di Livenza, Italy and Rovinj, Yugoslavia. Tunis (Tunisia). p. 413-432. Microfiche no: 86X01803.
Project: RAB/83/01 - Regional Mediterranean Aquaculture Development.

The quality control of feed ingredients used in compound aquaculture feeds is discussed, including aspects of protein and lipid quality, vitamin function and stability, and the presence of anti-nutritional factors.

122. **Arlati, G.** May 1986. Intensive rearing of eel. Technics used for intensive rearing and alimentation of fish and shellfish. Lectures given at the 6th Training session, 3-15 June 1985, Villanova di Motta di Livenza, Italy and Rovinj, Yugoslavia. Tunis (Tunisia). p. 258-280. Microfiche no: 86X01803.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

Intensive rearing techniques for eel (Anguilla anguilla) are described, including site selection requirements, elver weaning and rearing strategies, dietary nutrient requirements, feed composition and farm feeding methods.

123. **Fanciulli, G.** June 1987. Production of phyto and zooplankton. Production in marine hatcheries, training session Rovinj, Zadar (Yugoslavia), 10-28 February 1986. Edited by B.Loix. Tunis (Tunisia). p. 99-113. Microfiche no: 87268293.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

The production of phytoplankton and zooplankton in Japan as live food organisms for marine fish larvae, crustaceans and molluscs is discussed, with particular reference given to the techniques employed for the mass production of rotifers (Brachionus plicatilis).

124. **Franicevic, V.; Lisac, D.; Buble, J.; Leger, P.; Sorgeloos, P.** June 1987. International study on Artemia. XLII. The effect of the nutritional quality of Artemia on the growth and survival of sea-bass (Dicentrarchus labrax L.) larvae in a commercial hatchery. Production in marine hatcheries, training session Rovinj, Zadar (Yugoslavia), 10-28 February 1986. Edited by B. Loix. Tunis (Tunisia). p. 139-145. Microfiche no: 87X01320.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

Details are given of an experiment conducted to determine the effects of Artemia nauplii quality on the larval production of European sea bass (Dicentrarchus labrax). Findings show that dietary supplementation with essential fatty acids through Artemia enrichment significantly improved larval survival and production success.

125. **Ghion, F.** May 1986. Intensive rearing of mullet. Technics used for intensive rearing and alimentation of fish and shellfish. Lectures given at the 6th Training session, 3-15 June 1985, Villanova di Motta di Livenza, Italy and Rovinj, Yugoslavia. Tunis (Tunisia). p. 282-307. Microfiche no: 86X01803.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

An account is given of the development of mullet (Mugil and Liza sp.) culture in Italy and in particular concerning the development of artificial feeds for the species. Information is presented on the growth potentials of mullet under a variety of different farming conditions and concerning their natural feeding habits and response to different experimental diet formulations and feeding regimes.

126. **Guillaume, J.** May 1986. Marine fish feed: Mediterranean species needs. Technics used for intensive rearing and alimentation of fish and shellfish. Lectures given at the 6th Training session, 3-15 June 1985, Villanova di Motta di Livenza, Italy and Rovinj, Yugoslavia. Tunis (Tunisia). p. 384-412. Microfiche no: 86X01803.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

A review is given of the nutrient requirements and nutrition of marine fish, with particular reference to the dietary energy, protein, fatty acid, vitamin and mineral requirements of the European seabass (Dicentrarchus labrax) and gilthead seabream (Sparus auratus).

127. **Hellin, H.** May 1986. Intensive rearing of sea-bass (Dicentrarchus labrax) and gilthead sea-bream (Sparus auratus) in raceways: biological, technological aspects of fattening. Technics used for intensive rearing and alimentation of fish and shellfish. Lectures given at the 6th Training session, 3-15 June 1985, Villanova di Motta di Livenza, Italy and Rovinj, Yugoslavia. Tunis (Tunisia). p. 222-239. Microfiche no: 86X01803.

Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

The rearing of seabass (Dicentrarchus labrax) and seabream (Sparus auratus) is discussed, outlining fattening procedures. The rearing program, water management and feeding operations are detailed. A pilot hatchery farm in France is described.

128. **Kitajima, C.** June 1987. Fry production techniques for red sea bream, Pagrus major, in Japan. Production in marine hatcheries, training session Rovinj, Zadar (Yugoslavia), 10-28 February 1986. Edited by B. Loix. Tunis (Tunisia). p. 272-300. Microfiche no: 87268293.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

The rearing techniques employed in Japan for larval and juvenile red sea bream (Pagrus major) are described, with particular reference given to feeding practices used and the culture and nutritional value of live food organisms for use as fish food.

129. **Le Moulac, G.** May 1986. Post larvae production of P. japonicus, increase in productivity by modifying the feed sequence. Technics used for intensive rearing and alimentation of fish and shellfish. Lectures given at the 6th Training session, 3-15 June 1985, Villanova di Motta di Livenza, Italy and Rovinj, Yugoslavia. Tunis (Tunisia). p. 347-352. Microfiche no: 86X01803.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

The paper describes the hatchery rearing techniques employed for the mass production of Penaeus japonicus post-larvae in France, detailing in particular the live food and compound feed sequences and unit production costs.

130. **Loix, B.**. Editor. June 1987. Production in marine hatcheries, training session Rovinj, Zadar (Yugoslavia), 10-28 February 1986. Tunis (Tunisia). 387 p. Microfiche no: 87X01320.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

Nineteen papers are presented in the proceedings of the training session and include, 1) fish and shellfish farming in the LIM canal, 2) marine aquaculture: experience of the CENMAR, 3) marine fish hatcheries: site-production programme-dimensioning, 4) marine fish hatcheries: structures-equipment-economic aspects, 5) the conception of intensive type fish rearing facilities with partial or total water regeneration, 6) use of thermic discharges, 7) production of phyto and zooplankton, 8) microorganisms used in aquaculture: the natural zooplankton yield, 9) increased yields of marine fish and shrimp production through application of innovative techniques with Artemia, 10) international study on Artemia. XLII. The effect of the nutritional quality of Artemia on the growth and survival of sea-bass (Dicentrarchus labrax) larvae in a commercial hatchery, 11) reproduction and larval rearing of penaeids, 12) the production of shrimp post-larvae: the present situation of Penaeus japonicus hatcheries, 13) larval rearing of bivalve molluscs, 14) mullet: artificial propagation, 15) tilapia culture, 16) larval rearing, weaning and first fattening of sole and turbot, 17) fry producing techniques of red-sea-bream, Pagrus major, in Japan, 18) four marine spawners in European hatcheries, and 19) larval shrimp feeding: crustacean tissue suspension - a practical alternative for shrimp culture.

131. **Lumare, F.; Andreoli, C.; Guglielmo, L.; Maselli, M.A.; Piscitelli, G.; Scovacricchi, T.; Tolomio, C.** May 1986. Trophic community correlations in fertilized ponds for the commercial culture of the Kuruma prawn Penaeus japonicus Bate in the north Adriatic Sea (north-east coast of Italy). Technics used for intensive rearing and alimentation of fish and shellfish. Lectures given at the 6th Training session, 3-15 June 1985, Villanova di Motta di Livenza, Italy and Rovinj, Yugoslavia. Tunis (Tunisia). p. 308-332. Microfiche no: 86X01803.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

The paper reports on an analysis made of the trophic food chains operating within a fertilized extensive shrimp pond situated on the North-eastern coast of Italy. Ponds were stocked with Penaeus japonicus post-larvae (0.037 - 0.043 g initial body weight) at a rate of 1 to 3/m^2 and fertilized with a mixture of inorganic fertilizer and dried chicken manure over a 84 to 135-day

shrimp rearing period. Shrimp production rates are discussed in relation to reported water quality, phytoplankton, zooplankton and benthos analyses.

132. **Menu, B.** June 1987. Larval rearing, weaning and first fattening of sole and turbot. Production in marine hatcheries, training session Rovinj, Zadar (Yugoslavia), 10-28 February 1986. Edited by B. Loix. Tunis (Tunisia). p. 256-270. Microfiche no: 87X01320.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

The culture of sole (Solea vulgaris) and turbot (Scophthalmus maximus) is discussed, including the feeding practices employed during larval rearing, weaning, and first fattening. In addition information is presented on the growth rate and farming potential of the species compared with other European marine fish and salmonids.

133. **Ponticelli, A.** June 1987. Microorganisms used in aquaculture - the natural zooplankton yield. Production in marine hatcheries, training session Rovinj, Zadar (Yugoslavia), 10-28 February 1986. Edited by B. Loix. Tunis (Tunisia). p. 115-129. Microfiche no: 87268293.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

The production of zooplankton as live food for the larval stages of marine aquaculture species is discussed, including 1) intensive zooplankton production techniques in large volumes, 2) extensive production techniques, and 3) pond oxidation production techniques. Examples of zooplankton production techniques employed in Italy are given.

134. **Sabaut, J.J.** May 1986. Industrial manufacture of compound food for marine species. Technics used for intensive rearing and alimentation of fish and shellfish. Lectures given at the 6th Training session, 3-15 June 1985, Villanova di Motta di Livenza, Italy and Rovinj, Yugoslavia. Tunis (Tunisia). p. 353-365. Microfiche no: 86X01803.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

The paper discusses the industrial manufacture of compound feeds for marine finfish under the following headings: 1) nutrient requirements of the species reared, including dietary protein and amino acid requirements, 2) availability of raw materials, including feed ingredient composition tables, and 3) technological aspects of feed manufacture.

135. **Sorgeloos, P.; Leger, P.; Lavens, P.; Tackaert, W.** June 1987. Increased yields of marine fish and shrimp production through application of innovative techniques with Artemia. Production in marine hatcheries, training session Rovinj, Zadar (Yugoslavia), 10-28 February 1986. Edited by B. Loix. Tunis (Tunisia). p. 131-137. Microfiche no: 87X01320.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

The paper summarizes the essential role played by brine shrimp Artemia in the intensive rearing of marine finfish and crustacean larvae, and briefly discusses Artemia cyst production and potentials, and nutritional value and Artemia nutrient enrichment techniques.

136. **Tacon, A.G.J.** May 1986. Feeding principles for marine fish under intensive culture. Technics used for intensive rearing and alimentation of fish and shellfish. Lectures given at the 6th Training session, 3-15 June 1985, Villanova di Motta di Livenza, Italy and Rovinj, Yugoslavia. Volume II. Tunis (Tunisia). p. 366-383. Microfiche no: 86X01803.
Project: RAB/83/016 - Regional Mediterranean Aquaculture Development.

The paper first sets out the basic theoretical principles for feeding marine finfish under intensive culture conditions and then lists the factors influencing the commercial choice of feeding strategy, including feed availability and handling, feed performance, and food and feeding cost per unit of production. Examples of hatchery feeding strategies for marine finfish larvae and guidelines for their assessment are given. In addition, the paper discusses specific difficulties associated with the feeding of marine fish, including live food requirement during first feeding; fish feeding behaviour and diet water stability; and dietary protein requirement.

ASSISTANCE TO MEDRAP

137. **Batista, I.** 1987. Fish silage: preparation and uses. Nutrition in Marine Aquaculture. Training Session, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 227-248. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

The production of acid preserved fish silage is described, detailing the following processes: liquefaction of fish silage, stability of amino acids, changes in the fish oil, and vitamin degradation. Fermented fish silage is also discussed, and a comparison made between fish silage and fish meal within fish feeds.

138. **Bruno, A.** February 1986. Lectures on nutrition: Introduction. Lectures presented to the Training Course on Aquaculture in Policoro, Italy. Tunis (Tunisia). 26 p.
Project: GCP/REM/049/ITA - Assistance to MEDRAP. MEDRAP Technical Document 86/02.

The paper introduces fish nutrition under the following headings: 1) basic anatomy of the digestive system, 2) digestion and absorption, 3) energy metabolism in fish, and 4) energy sources, including lipid, carbohydrate and protein nutrition.

139. **Bruno, A.** Editor. 1987. Training Session on Nutrition in Marine Aquaculture. Lisbon, 20-30 October 1986. Rome (Italy). 398 p. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

The training session on nutrition in marine aquaculture contains 14 individual paper presentations, including papers on: 1) proteins, 2) lipids and fatty acids in fish nutrition, 3) carbohydrates, 4) vitamins and mineral requirements of fish, 5) comparative nutrition for fish and crustaceans: digestion and digestive secretions in crustaceans, 6) feeding and digestion within bivalves, 7) the use of raw materials in fish feeding, 8) fish silage: preparation and uses, 9) fish feeds processing and technology, 10) feeding stimulants for fish: application in mariculture, 11) the use of microparticles in aquaculture, 12) experimentation in nutrition, 13) feeding in marine aquaculture by MEREA, and 14) functional morphology of the digestive system and bioenergetics in fish.

140. **Ceccaldi, H.J.** 1987. Comparative nutrition for fish and crustaceans. Digestion and digestive secretions in crustaceans. Training Session on Nutrition in Marine Aquaculture, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 109-143. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

The nutritional requirements of marine finfish and shrimp are broadly discussed, and in particular with reference to the larval growth stages and digestive process. The digestive system of crustaceans is described in detail and the progressive development of digestive enzymatic activities with age described. Applications of such physiological studies in the production of compound aquaculture feeds are briefly examined.

141. **Cowey, C.B.** 1987. Proteins. Training Session on Nutrition in Marine Aquaculture, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 1-14. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

The paper discusses the methodology employed by researchers for the estimation of dietary protein and amino acid requirements and summarizes the known dietary requirements for these nutrients in farmed fish. The dietary requirements are discussed in relation to fish size, water temperature, salinity and diet composition.

142. **Cowey, C.B.** 1987. Carbohydrates. Training Session on Nutrition in Marine Aquaculture, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 61-67. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

The utilization and digestibility of dietary carbohydrates in common carp, red seabream, yellowtail, channel catfish and rainbow trout is briefly reviewed. In addition aspects of carbohydrate metabolism such as glycogen utilization and glucose phosphorylation are discussed, and a method for measuring glucose utilization isotopically presented.

143. **de la Pomelie, C.** 1987. Feeding in marine aquaculture by MEREA (Mediterranean Research Team in Aquaculture). Training Session on Nutrition in Marine Aquaculture, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 331-357. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

The primary role played by food during the culture of marine finfish and shrimp is discussed under the following headings: 1) hatchery phase, including live food requirements and feeding costs for larval Penaeus japonicus and European sea bass (Dicentrarchus labrax), and weaning, nursery and broodstock feeding sequences for P. japonicus, D. labrax and sea bream (Sparus auratus), 2) fattening phase, including semi-intensive and intensive feeding practices, and 3) food distribution methods, including the advantages and disadvantages of manual and automatic feed distribution systems.

144. **Freddi, A.** April 1985. Sea bass (Dicentrarchus labrax) and gilthead sea bream (Sparus auratus): 2. Larval rearing. Lecture presented during the Training course in Aquaculture at Policoro, Italy. Tunis (Tunisia). 83 p.
Project: GCP/REM/049/ITA - Assistance to MEDRAP. MEDRAP Technical Document 85/05.

The report reviews the larval rearing procedures developed by the author for sea bass (Dicentrarchus labrax) and gilthead sea bream (Sparus auratus), and is presented under the following headings, 1) egg collection, incubation and hatching, 2) larval rearing, including feeding, 3) data recording, and 4) daily work schedule.

145. **Gabaudan, J.** 1987. Functional morphology of the digestive system and bioenergetics in fish. Training Session on Nutrition in Marine Aquaculture, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 359-383. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

The structure and function of fish organs responsible for ingestion, digestion and absorption are examined. The digestibility of raw materials are discussed with respect to accurate feed formulation. Techniques for the determination of gastrointestinal evacuation rate are detailed together with the nutritional and environmental factors affecting this parameter. Nutritional bioenergetics of fish are also considered, examining energy metabolism, energy requirements and sources of energy.

146. **Gatesoupe, F.J.** 1987. The use of microparticles in aquaculture. Training Session on Nutrition in Marine Aquaculture, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 281-301. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

An examination is made of the use of microparticles as larval feed within the aquaculture industry. Natural microparticles are described, including bacteria, yeasts, algae, copepods, rotifers, Artemia and fish eggs. Methods for producing artificial compound microparticles are detailed; pressure cooking methods such as flaking and extrusion cooking, gels, microencapsulation, and microcoating. The choice of microparticles to be used is discussed in relation to the intended aquaculture species to be cultured.

147. **Guillaume, J.** 1987. The use of raw materials in fish feeding. Training Session on Nutrition in Marine Aquaculture, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 199-225. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

The factors affecting the choice of individual raw ingredients within aquaculture feeds is discussed, and in particular the presence or not of anti-nutritional and toxic substances. Following a full description of the different anti-nutritional and toxic factors present within individual feed ingredients, quality control procedures are outlined and brief summaries also presented for the major animal and plant ingredients.

148. **Koenig, J.** 1987. Vitamin and mineral requirements with fish. Training Session on Nutrition in Marine Aquaculture, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 69-107. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

The dietary vitamin and mineral requirements of fish are reviewed. Dietary vitamin requirements are discussed in relation to their biological function within the body and information presented on the principal vitamin deficiency symptoms, dietary requirements, antagonisms, and vitamin sources. The essential minerals are considered individually, describing dietary requirements and deficiency symptoms in cultured fish.

149. **Leger, C.** 1987. Lipids and fatty acids in fish nutrition. Training Session on Nutrition in Marine Aquaculture, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 15-59. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

Following a general description of the classification of the lipids, the characteristics of individual fish lipids are examined, including lipid body partition, lipid structure and metabolism. Nutritional implications are considered, detailing lipid origins and progression in fish and consequences on dietary nutritional requirements.

150. **Loix, B.; Freddi, A.** May 1985. Phyto-zooplankton rearing and utilization. Lectures presented at the Training course in Aquaculture at Policoro, Italy. Tunis (Tunisia). 72 p.
Project: GCP/REM/049/ITA - Assistance to MEDRAP. Technical Document 85/04.

The paper reviews the production of phytoplankton, rotifers and Artemia salina for use as aquaculture feed, and is presented under the following headings: 1) phytoplankton, including monoculture techniques within small water volumes and fertilization techniques for large water volumes, 2) rotifers, including intensive rearing techniques within small water volumes and production programming, and 3) Artemia salina, including utilization techniques and data recording.

151. **Mackie, A.M.** 1987. Feeding stimulants for fish: applications in mariculture. Training Session on Nutrition in Marine Aquaculture, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 271-279. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

The paper reviews the use of chemical feeding stimulants for fish, and in particular for marine finfish. A survey of food organisms and their component phagostimulants for individual fish species is presented.

152. **Melcion, J.P.** 1987. Fish feeds processing and technology. Training Session on Nutrition in Marine Aquaculture, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 249-270. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

The paper reviews the fish feed manufacturing process under the following headings: 1) grinding, including definitions, hammermill description and grinding parameters, 2) mixing, including definitions, mixing equipment and demixing, 3) dry pelleting, including definitions, principles and equipment, and factors affecting pelleting, 4) extrusion cooking, including principle, extruders, extrusion variables and application, and 5) wet granulation or pelleting. In addition, the paper provides a list of equipment suppliers for individual mixers, grinders, pelletizers and extruders.

153. **Metailler, R.** 1987. Experimentation in nutrition. Training Session on Nutrition in Marine Aquaculture, Lisbon, 20-30 October 1986. Edited by A. Bruno. Rome (Italy). p. 303-330. Microfiche no: 88W00168.
Project: GCP/REM/049/ITA - Assistance to MEDRAP.

The paper discusses the factors which need to be taken into account when planning and conducting experiments in aquaculture nutrition, including data handling and analysis. The paper is presented under the following headings: 1) what is meant by experimentation in nutrition, 2) starting point: a question is asked, objectives are defined, 3) experimental protocol, 4) elaboration of an experimental plan, including replication, 5) the start, follow up and end of an experiment, 6) the different results, including weight gain and feed utilization efficiency, and 7) data processing.

AFRICA

ESTABLISHMENT OF AFRICAN REGIONAL AQUACULTURE CENTRE

154. **Campbell, D.** February 1987. A review of the biology and culture of Tilapia guineensis. Port Harcourt (Nigeria). 20 p. Microfiche no: 87X01681.
Project: RAF/82/009 - Establishment of African Regional Aquaculture Centre. Working Paper 3/87.

The paper reviews the identification, range, reproduction, fecundity, feeding habits, physiological parameters, fry rearing techniques, and the culture in ponds, enclosures, tanks, and cages of Tilapia guineensis. The fish is euryhaline, found in estuaries and lagoons of West Africa. It is a nest building substrate spawner. 2.7 mm eggs hatch in 2 days (26°C) producing 5-6 mm larvae. Number produced is 200-3000. Fry are produced in ponds, tanks, and cages. Pond culture yields 1.5 to 3.3 t/ha/yr using fertilizers and feeding. In enclosure farming, growth was 0.38 g/day; growth stopped for 2 months lowering values. In tanks and cages, best growth was 0.6 g/day. Recommendations to improve growth rates include genetic selection and nutritional studies.

155. **Campbell, D.** 1987. A review of the culture of Sarotherodon melanotheron in West Africa. Port Harcourt (Nigeria). 23 p. Microfiche no: 87X02103.
Project: RAF/82/009 - Establishment of African Regional Aquaculture Centre. Working Paper 5.

The paper reviews results of the culture of Sarotherodon melanotheron in West Africa and problems encountered. Females can mature at 4.0 cm SL and males at 4.5 cm SL. The species grows and reproduces at pH 3.5 to 5.2. It can feed on phytoplankton, benthic diatoms, filamentous algae, periphyton, detritus, and artificial feeds; 4-5 week feeding with methyltestosterone at 40 mg/kg feed gave over 95 percent males. Under culture conditions in ponds, enclosures, and cages, growth is 0.5 to 0.7 g/day until a mean weight of 25-35 g in ponds and 50 - 60 g in cages and enclosures when stunting occurs. In ponds, growth is the same if fed wheat bran, chicken mash, pellets at 5 percent of the biomass, or with an application of manure at 1.8 T/ha. This fish can be raised efficiently to a weight of 35-50 g using ponds, enclosures, or cages; a limited market for this size exists. For larger fish and higher production, the acadja or brush park technique gives production of 7-20 T/ha/year with a size range after 1 year of 20-560 g. Research recommendations include a low input pond system, density studies in cages and enclosures, and determining optimum quantities of wood in the acadja. The acadja could be adapted to pond conditions.

156. **Delince, G.A.; Campbell, D.; Janssen, J.; Kutty, M.N.** July 1987. Seed production. Lectures presented at ARAC (African Regional Aquaculture Centre) for the senior aquaculturists course. Port Harcourt (Nigeria). 118 p. Microfiche no: 297821.
Project: RAF/82/009 - Establishment of African Regional Aquaculture Centre. ARAC Working Paper 13.

The report discusses finfish seed production and transportation techniques, and in particular methods for the mass propagation of nile Tilapia (Tilapia nilotica) and African catfish (Clarias gariepinus). For each fish species, information is provided on the various spawning and rearing techniques commonly employed, including the food and feeding of the fry and fingerlings within tanks, earthen ponds or floating net cages.

157. **Kutty, M.N.** April 1987. Site selection for aquaculture: Biological productivity of water bodies. Lectures presented at ARAC (African Regional Aquaculture Centre) for the Senior Aquaculturists Course. Port Harcourt (Nigeria). 15 p. Microfiche no: 297787.
Project: RAF/82/009 - Establishment of African Regional Aquaculture Centre. ARAC Working Paper 12(10).

The paper discusses the biological productivity of water bodies and is presented under the following headings: 1) ecosystem, 2) habitat and ecological niche, 3) food cycle in water bodies, 4) concept of productivity, 5) primary production in fish ponds, 6) relationship between primary production and fish production, and 7) measurement or productivity.

158. **Tsadik, G.G.; Kutty, M.N.** 1987. Influence of ambient oxygen on feeding and growth of the tilapia, Oreochromis niloticus (Linnaeus). Port Harcourt (Nigeria). 16 p. Microfiche no: 87X02106.
Project: RAF/82/009 - Establishment of African Regional Aquaculture Centre. Working Paper 10.

Oreochromis niloticus (8.1 ± 0.5 g) grown in fresh water at 28 ± 2°C for 35 days at various ambient oxygen concentrations, below air saturation in static water aquaria, were seriously affected in their feeding, assimilation and growth by ambient oxygen. While the ambient oxygen maintained was reduced from about 90 percent air saturation (about 7 mg/l) to about 20 percent air saturation (about 1.5 mg/l) food consumed and assimilated decreased 40 and 60 percent respectively. Correspondingly, assimilation efficiency decreased from 80 to 50 percent, and conversion efficiency from 15 to 5 percent, while uncorrected FCR increased from 1.45 to 6.75. Under a simulated diel flux of oxygen (from about 20 to 200 percent air saturation) brought about by a induced bloom of plankton, growth rate of O. niloticus was considerably reduced when compared with those maintained at DO near saturation constantly.

PROJET REGIONAL DE RECHERCHE ET DE FORMATION PISCICOLES (CAMEROUN-REPUBLIQUE CENTRAFRICANE-GABON-REPUBLIQUE DU CONGO)

159. **Hastings, W.H.** January 1973. Experiences relatives a la preparation d'aliments des poissons et a leur alimentation. Rome (Italy). 23 p. Microfiche no: 24898.
Project: RAF/66/054 - Projet Regional de Recherche et de Formation Piscicoles (Cameroun-Republique Centrafricane-Gabon-Republique du Congo). Report RAF/66/054/1.

The report reviews the feed ingredients available for fish feeding in the Central African Republic, and reports the results of experiments on fish feeding and on the manufacture of fish feeds.

ASIA AND THE PACIFIC

ASEAN/UNDP/FAO REGIONAL SMALL-SCALE COASTAL FISHERIES DEVELOPMENT PROJECT

160. **ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project.** October 1989. Report of the workshop on shrimp and finfish feed development, Johore Bahru (Malaysia), 25-29 October 1988. Manila (Philippines). 167 p.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

The workshop proceedings on shrimp and finfish feed development is presented in two main parts; the first part consisting of twelve technical paper presentations, and the second part consisting

of country reviews for Indonesia, Malaysia, Philippines, Singapore and Thailand. The technical papers presented included: 1) formulated aquaculture feeds in Asia: Some thoughts on comparative economics, industrial potential, problems and research needs in relation to the small-scale farmer, 2) the feedmilling industry, the assessment of product quality and the economics of shrimp feeds, 3) formulated feeds of Penaeus monodon, 4) status of shrimp feed development at BADC, Jepara, Indonesia, 5) preliminary study on the effect of formulated feed using fermented aquatic weeds ingredient to the growth rate of red tilapia, 6) some aspects of the use and manufacture of formulated fish feeds, 7) the availability of formulated feeds, their manufacture and feed conversion values found in West Malaysia, 8) preliminary observations on the nutritional effects of a betaine/amino acid mixture: Survival, growth and food conversion of juvenile Penaeus monodon fed with Finnstim, 9) formulation of feeds for cage culture of finfish in Taal Lake, Philippines, 10) dietary protein requirement of early grow-out seabass (Lates calcarifer Bloch) and some observations on the performance of two practical formulated feeds, 11) effect of various protein levels of artificial diets mixed with minced fish flesh alone on growth of grouper (Epinephelus tauvina Forskal), and 12) possibility of using rotifer, Brachionus plicatilis as food for early stage of grouper larvae, Epinephelus malabaricus.

161. **ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project.** 1990. Report of the Training Course on Home-Made Feeds Preparation for Small-Scale Aquaculture Use, Iloilo (Philippines), 19-25 November 1990. Manila (Philippines). 93 p.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/90/GEN/18.

This training course was a follow-up of the workshop on finfish and shrimp feeds formulation which the ASEAN/UNDP/FAO fisheries project organized in 1988 in Johore Bahru, Malaysia. Lectures and laboratory work consisted of introduction to fish nutrition, feed formulation, prawn feed management, ingredients for feed manufacture, feed preparation and storage, and chemical evaluation of feeds. The course was aimed to provide practical knowledge and skills to fish farmers and extension technicians in the preparation of feed for small-scale aquaculture. Eleven participants from ASEAN countries attended the course.

162. **Basa, S.S.** October 1989. Formulation of feeds for cage culture of finfish in Taal Lake, Philippines. Report of the Workshop on Shrimp and Finfish Feed Development, Johore Bahru (Malaysia), 25-29 October 1988. Manila (Philippines). p. 85-90.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

This paper is the result of an experiment carried out at Taal Lake, Batangas, south of Manila, where formulated feeds using local ingredients were tested. Three floating net cages each measuring 5 x 10 x 5 m were stocked with 1,800 Tilapia nilotica fingerlings 8-10 g in weight. Cage 1 was fed with test diet: cage 2 was fed only ricebran, and cage 3 received no supplemental feed. Growth rate, feeding rate and feed conversion efficiency were determined over the 104-day feeding experiment and the results discussed in the light of current commercial farming practices using similar fish cage sizes.

163. **Basa, S.S.** October 1989. Country paper (Philippines): Feeds and feedstuffs for aquaculture use in the Philippines. Report of the Workshop on Shrimp and Finfish Feed Development, Johore Bahru (Malaysia), 25-29 October 1988. Manila (Philippines). p. 131-142.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

The paper reviews the feeds and feedstuffs used for aquaculture in the Philippines, including the available feed ingredients and their composition, and aquaculture feed manufacturers present, including the formulated feeds produced for shrimp and finfish (Oreochromis niloticus).

164. **Chin, K.** October 1989. The feedmilling industry, the assessment of product quality and the economics of shrimp feeds. Report of the Workshop on Shrimp and Finfish Feed Development, Johore Bahru (Malaysia), 25-29 October 1988. Manila (Philippines). p. 31-34.

Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

The paper briefly describes the history of the feedmilling industry in Malaysia and in particular discusses: 1) shrimp culture and shrimp feeds in Malaysia, 2) product quality assessment, 3) economics of commercial shrimp feeds, and 4) the manufacture of shrimp feeds by Gold Coin.

165. **Chou, R.** October 1989. Country paper (Singapore): The current status and trend of finfish and shrimp feed development. Report of the Workshop on Shrimp and Finfish Feed Development, Johore Bahru (Malaysia), 25-29 October 1988. Manila (Philippines). p. 143-146.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

The paper describes the current status of feed development for the larval and grow-out stages of cultured shrimp and finfish in Singapore and then highlights the trends and prospects of the feeds sector.

166. **Delmendo, M.N.** November 1989. Some advances attained in shrimp farming research and management practices: insights to future prospects for expansion of production. Manila (Philippines). 63 p.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Technical Report ASEAN/SF/89/Tech.10.

The report reviews information on shrimp farming research and management practices, and is presented under the following headings: 1) seed production, including broodstock quality and shrimp hatchery operations, 2) shrimp grow-out management techniques, including extensive, semi-intensive and intensive farming techniques, 3) important considerations for intensification of shrimp farming management techniques, including water exchange, feeds, seeds supply and rearing, 4) insight to the future of shrimp farming, including market considerations, increasing the levels of productivity, and diversification of farmed shrimp species, and 5) further areas of research for future expansion of shrimp culture. In addition annexes are provided on: 1) engineering considerations for disease and stress prevention in shrimp hatcheries and ponds, 2) formulated diets tested and proven under intensive shrimp rearing conditions, and 3) how to formulate feeds for shrimp.

167. **Delmendo, M.N.; Zabala, P.T.** December 1989. An annotated bibliography on shrimp feeds and nutrition. Manila (Philippines). 38 p.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. General Report ASEAN/SF/89/GEN/12.

The report presents an annontated list of 102 published papers and reports concerned with feed technology, nutrition and feeds formulation for larvae and adult shrimp (Penaeid sp.) and prawns (Macrobrachium sp.).

168. **Delmendo, M.N.; Zabala, P.T.** December 1989. An annotated bibliography on finfish feeds and nutrition. Manila (Philippines). 40 p.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. General Report ASEAN/SF/89/GEN/13.

The report presents an annotated list of 97 published papers and reports concerned with feed technology, nutrition and feeds formulation for larvae and adult fish.

169. **Hassan, I.A.; Hanafi, H.H.; Che Musa, C.U.B.; Pathmasothy, S.** October 1989. Country review paper (Malaysia) - Status of shrimp and finfish feeds in Malaysia. Manila (Philippines). p. 123-130.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

Feed is one of the factors which plays an important role in determining the successful development of the aquaculture industry. In marine shrimp and finfish culture it has been proven that more than 50 percent of cost of production goes to the feed for the cultured animals. This paper discussed briefly the present status of feeds for marine shrimp and finfish, the major issues faced by the feedmilling industry and the potential development of the feed industry. It also identifies some of the major steps needed to be taken by both the government and private sectors in order to ensure the development of marine shrimp and finfish feed industry in Malaysia.

170. **Kontara, E.K.** August 1988. Shrimp culture management techniques. Report of the Training Course on Shrimp Culture, Jepara (Indonesia), 2-19 December 1987. Manila (Philippines). p. 32-38.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/88/GEN/3.

The paper reviews the physico-chemical parameters that affect shrimp culture operations and is presented under two main headings, namely 1) water quality, and 2) pond management, including pond preparation, stocking, fertilization, and feeds and feeding.

171. **New, M.B.** October 1989. Formulated aquaculture feeds in Asia: some thoughts on comparative economics, industrial potential, problems and research needs in relation to the small-scale farmer. Report of Workshop on Shrimp and Finfish Feed Development. Manila (Philippines). p. 19-30.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

The paper first discusses the economic benefits of feeds use and introduces the concepts of 'incidence of cost' and 'annual profit index'. This is followed by comments on the growing use of commercially compounded feeds in Asian aquaculture and on one of the possible alternatives to their use for some farmers; namely, the use of 'home-made' feeds. Finally, the paper highlights some of the current problems of the aquaculture feed industry and some of the as-yet unsolved problems in the field, including the current dependence of the sector upon feed ingredients of marine origin.

172. **Pascual, F.P.** October 1989. Formulated feeds of **Penaeus monodon**. Report of the Workshop on Shrimp and Finfish Feed Development, Johore Bahru (Malaysia), 25-29 October 1988. Manila (Philippines). p. 35-44.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Working Paper ASEAN/SF/89/GEN/11.

The paper discusses the food and feeding habits of Penaeus monodon, present knowledge of nutrient requirements and available formulations in the market including those developed at the Aquaculture Department, Southeast Asian Fisheries Development Centre. Economics of feeding is also presented. Further research on the use of indigenous feed ingredients and nutritional requirement studies should be carried out to lower cost of feed and increase profits for the farmers.

173. **Pascual, F.P.** 1991. A practical guide to the preparation of home-made feeds for aquaculture. Manila (Philippines). 31 p.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. ASEAN/SF/91/Manual 7.

All living organisms need energy to perform physical and biological functions. Aside from energy, fish need about 40 nutrients or food substances for normal growth. These nutrients are classified into five major groups: protein and amino acids, lipids and fatty acids, carbohydrates, vitamins and minerals. Procedures for feed preparation, including the equipment needed and suggested fish and shrimp diets are contained in this paper. Determination of the amount of daily feed ration and monitoring feed consumption are also discussed. The manual is presented under the following headings: 1) introduction; 2) what are the nutrient requirements of fishes; 3) how to prepare fish feeds; 4) when to feed fish and shrimps; 5) how to determine the amount of daily feed ration; 6)

how to monitor feed consumption and efficiency; 7) some tips for the fish farmer; and 8) suggested reading.

174. **Pathmasothy, S.; Jin, L.T.** October 1989. The availability of formulated feeds, their manufacture and feed conversion values found in West Malaysia. Report of the Workshop on Shrimp and Finfish Feed Development, Johore Bahru (Malaysia), 25-29 October 1988. Manila (Philippines). p. 65-70.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

The paper reviews freshwater fish culture in Malaysia and in particular discusses: 1) the nutritional requirements of the locally cultivated fish species, 2) the status of manufacturing fish feed in Malaysia, 3) the availability of formulated fish feeds, and 4) the feed conversion efficiency of local feeds for Pangasius sp., Leptobarbus sp., Tilapia sp. and Clarias sp.

175. **Pechmanee, T.** August 1989. Food organisms for seabass larval rearing. Report of the Training Course on Seabass Breeding and Culture, Satul (Thailand), 1-21 August 1988. Manila (Philippines). p. 41-44. Microfiche no: 291853.
Project: RAS/84/016. ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/9.

The paper summarizes the use of the rotifer (Brachionus plicatilis) and brine shrimp nauplius (Artemia salina) as a live food for seabass (Lates calcarifer) larvae. Information is presented on rotifer culture methods, including rotifer feeding and enrichment, and on Artemia hatching and harvesting methods.

176. **Pechmanee, T.; Assavaaree, M.; Bunliptanon, P.; Akkayanon, P.** October 1989. Possibility of using rotifer, Brachionus plicatilis as food for early stage of grouper larvae, Epinephelus malabaricus. Report of the Workshop on Shrimp and Finfish Feed Development, Johore Bahru (Malaysia), 25-29 October. Manila (Philippines). p. 109-112.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

The paper briefly describes the results of an experimental feeding trial conducted in Thailand using the rotifer (Brachionus plicatilis) as food for feeding 3 to 10 day-old grouper larvae. A survival rate of 33-55 percent was reported for 15 day-old grouper larvae using rotifers cultured on cod liver-enriched diets.

177. **Pimoljinda, T.** October 1989. Effect of various protein levels of artificial diets mixed with minced fish flesh and minced fish flesh alone on the growth of grouper Epinephelus tauvina Forskal. Report of Workshop on Shrimp and Finfish Feed Development. Manila (Philippines). p. 103-108.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

This study was conducted to determine the effect of mixed 45, 50 and 55 percent protein artificial diets with minced fish flesh and a pure minced fish flesh diet on growth, feed conversion and survival of grouper. Fishes with initial size of 0.91 g in weight and 4.38 cm in length were fed on the experimental diets in 85 x 135 x 100 cm concrete tanks for 60 days. The result revealed that the growth rate of fish fed with artificial diets plus minced fish flesh was significantly higher than fish fed minced fish flesh alone. Survival rate of fish fed with 45, 50 and 55 percent protein artificial diets plus minced fish flesh were 82.08, 87.50, 87.08 percent and minced fish flesh alone was 84.58 percent; feed conversion rates were 2.83, 2.77, 2.68 and 3.95, respectively.

178. **Seong, K.F.** October 1989. Some aspects of the use and manufacture of formulated fish feeds. Report of the Workshop on Shrimp and Finfish Feed Development, Johore Bahru (Malaysia), 25-29 October 1988. Manila (Philippines). p. 59-64.

Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

The paper discusses the use and manufacture of fish feeds in Malaysia and is presented under the following main headings: 1) types of feed, 2) production capacity and needs, 3) floating feeds, 4) constraints to feed development, and 5) some quality considerations.

179. **Sumeru, S.U.** October 1989. Status of shrimp feed development at BADC, Jepara, Indonesia. Report of the Workshop on Shrimp and Finfish Feed Development, Johore Bahru (Malaysia), 25-29 October 1988. Manila (Philippines). p. 45-52.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

The paper describes the activities of the Brackishwater Aquaculture Development Centre (BADC) in Indonesia concerning the development of shrimp feeds, and in particular concerning the development of wet larval diets, artificial plankton, post-larval and grow-out diets, including feed formulations for Penaeus monodon feeds.

180. **Sumeru, S.U.** August 1988. Formulated feed for penaeid shrimp in pond culture. Report of the Training Course on Shrimp Culture, Jepara (Indonesia), 2-19 December 1987. Manila (Philippines). p. 45-49.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/88/GEN/3.

The paper briefly reviews the dietary nutrient requirements of shrimp (Penaeus monodon) and describes the various feed processing techniques employed for the manufacture of compound shrimp feeds. Examples of dietary formulations for practical shrimp feeds are given.

181. **Suprayitno, S.H.; Widagdo, D.** October 1989. Preliminary study on the effect of formulated feed using fermented aquatic weeds ingredient to the growth rate of red tilapia. Workshop on Shrimp and Finfish Feed Development, Johore Bahru (Malaysia), 25-29 October 1988. Manila (Philippines). p. 53-58.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

Feeding trials were conducted with red tilapia within 600 litre plastic lined wooden tanks. Twenty fish of average weight 4.29-5.25 g were stocked per tank. Four dietary formulations utilizing fermented ingredients (fermented Lemna sp., Salvinia sp., rice bran or trash fish silage) were compared with a commercial diet over a 40-day feeding period. All fish were fed ad libitum twice daily. Fish fed the ration containing fermented Lemna sp. had the highest growth rate and fish fed fermented rice bran the lowest growth rate. There was no significant difference in the growth response of fish fed the fermented Lemna sp. ration and the commercial control ration. There was an indication that Lemna sp. performed better than Salvinia sp. as a dietary protein source for fish. Survival rate was 100 percent for all treatments over the 40-day test period and water temperature ranged from 25 to 29°C.

182. **Suprayitno, S.H.; Widagdo, D.** October 1989. Country review paper (Indonesia). Report prepared for the Workshop on Shrimp and Finfish Feed Development, Johore Bahru (Malaysia), 25-29 October 1988. Manila (Philippines). p. 115-122.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

The paper reviews the status of aquaculture in Indonesia, and in particular: 1) discusses the feed ingredients available in the country, 2) feed supplies, including formulated feeds for milkfish, marine shrimp and carp, and 3) finally discusses current problems and constraints to the feed industry in Indonesia.

183. **Tattanon, T.; Maneewongsa, S.** August 1989. Rearing of seabass larvae and fingerlings. Report of the Training Course on Seabass Breeding and Culture, Satul (Thailand), 1-21 August 1988. Manila (Philippines). p. 31-40. Microfiche no: 291853.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/9.

The paper reviews the rearing techniques employed in Thailand for seabass (Lates calcarifer) larvae and fingerlings. The food and feeding of seabass larvae and juveniles is discussed, including the use of rotifers, Artemia, Daphnia, Moina, Acetes and minced fish flesh as food items during the culture cycle.

184. **Ung, E.H.; Junilla, M.** October 1989. Preliminary observations on the nutritional effects of a betaine/amino acid mixture: survival, growth and food conversion of juvenile Penaeus monodon fed with Finnstim. Workshop on Shrimp and Finfish Feed Development. Manila (Philippines). p. 71-84.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

A commercially available betaine (trimethylglycine)/amino acid mixture was tested on juvenile Penaeus monodon housed in individual test chambers so as to rule out death due to cannibalism for 60 days. Three pelleted diets were used using a commercial basal formulation. The Finnstim mixture was included in at 0, 1 and 2 percent inclusion rates. Enhanced growth, food conversion and survival was observed. The control gave a 99.45 percent weight gain while the 1 and 2 percent regimes gave weight gains of 116.3 and 119.3 percent, respectively. Food conversion ratios of 3.74 and 3.94 were obtained for the 2 and 1 percent regimes, respectively, while the control performed less well at 4.64. Survival rates appeared to be enhanced at the 2 percent level only giving 88.8 percent survival while the 1 and 0 percent diets gave 72.5 and 70 percent survival rates, respectively. Possible physiological reasons explaining the observed results are discussed. Both choline chloride and DL-methionine which are also methyl group donors were not included in the diet.

185. **Unprasert, N.** October 1989. Country paper (Thailand): Fish feeds and feedstuffs used for aquaculture in Thailand. Report of the Workshop on Shrimp and Finfish Feed Development, Johore Bahru (Malaysia), 25-29 October 1988. Manila (Philippines). p. 147-155.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

The paper reviews fish feeds and feedstuffs used for aquaculture in Thailand, including 1) feed ingredients available in the country, 2) feedstuff supply, including feed manufacturing, 3) formulated feeds for shrimp and finfish, and 4) problems and constraints.

186. **Wong, F.J.; Chou, R.** October 1989. Dietary protein requirement of early grow-out seabass (Lates calcarifer Bloch) and some observations on the performance of two practical formulated feeds. Report of the Workshop on Shrimp and Finfish Feed Development. Manila (Philippines). p. 91-102.
Project: RAS/84/016 - ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project. Workshop Report ASEAN/SF/89/GEN/11.

The optimal dietary protein requirement of seabass, Lates calcarifer Bloch in early grow-out phase (71-182 g) was determined over a four-month (125 days) period using protein reference diets of crude protein (CP) 40, 45 and 50 percent, derived from a single protein source, fish meal. Dietary lipid was fixed at 12 percent. The study was carried out under controlled tank conditions, in triplicate, with trash fish as control feed. The optimal dietary protein requirement of seabass was 40-45 percent. This was determined by assessing fish growth rate, feed conversion ratio, protein efficiency ratio and apparent protein retention (protein conversion efficiency). Although fish growth rate was significantly higher with trash fish feed, feed conversion ratio (FCR) was not significantly different among treatments. Poorer protein utilization for growth in trash fish fed seabass was reflected in apparent protein retention figures which were significantly lower. This

is possibly related to digestible energy sources of the feed. A second experiment was conducted to assess the performance of two practical dry formulations made up from multiple protein sources on seabass from the same population. The cheaper local formulation containing 43 percent protein and 12 percent ether extractable fat performed better than imported seabass feed of higher protein content 50 percent and 16 percent ether extractable fat. Protein efficiency ratio of 1.66:1 with the local formulation was significantly higher than PERs with the imported seabass feed and trash fish. Protein quality of the formulated test diets was comparable, but was better in trash fish. Calculated digestible energy (DE) values for all diets were 3297-4160 kcal/kg or 131-218 mg/kcal of dry feed. In trash fish feed, 87.2 percent of total DE was derived from protein and the rest (12.8) from fat. In the test diets, 52.3-57.4 of total DE was derived from protein, 31.8-38.1 from fat and 9.6-12.1 from carbohydrate. Protein sparing was therefore more effective with the test diets than with trash fish, where the main energy source of the fish was likely to have been the protein. This could explain the significantly lower protein retention in seabass fed trash fish.

ESTABLISH NETWORK OF AQUACULTURE CENTRES IN ASIA

187. **Asian-Pacific Regional Research and Training Centre for Integrated Fish Farming,** Wuxi (China). September 1985. Integrated fish farming in China. Training manual. Bangkok (Thailand). 371 p. Microfiche no: 86X00887.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Training Manual 85/11.

The manual is divided into ten chapters under the following headings: namely 1) the biology of major freshwater cultivated fishes in China, 2) artificial propagation of black carp, grass carp, silver carp and bighead carp, 3) pond fertilization and fish feeds, 4) rearing of fry and fingerlings, 5) pond culture of food fish, 6) main fish diseases and their control, 7) introduction of Chinese integrated fish farming and its major models, 8) the statistical methods of planning and management of integrated fish farms, 9) animal raising and plant cultivation on an integrated fish farm, and 10) design and construction of an integrated fish farm.

188. **Freshwater Aquaculture Research and Training Centre of the Indian Council of Agricultural Research,** Dhauli, Bhubaneswar. September 1985. Guidelines for monitoring of productivity in fish ponds. Bangkok (Thailand). 19 p. Microfiche no: 86X00882.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 85/23.

A description is given of parameters selected for the environmental monitoring of fish pond productivity. The general morphometry of undrainable rural fish ponds, their chemical environment and nutrient status and their natural fish food resources are detailed. Primary production and related fish yields, and community metabolism and sediment oxygen consumption are also considered.

189. **Antiporda, J.L.** November 1986. Optimum dietary protein requirement for Macrobrachium rosenbergii juveniles. Bangkok (Thailand). 20 p. Microfiche no: 87X01054.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 86/45.

The dietary protein requirement of Macrobrachium rosenbergii juveniles was determined in growth trials performed in indoor aquaria using rations based on fish meal and shrimp meal as the main sources of protein. Five protein levels from 20-40 percent at 5 percent interval were tested to assess the best growth. Mean body weights and lengths of four replicate treatments were subjected to analyses of variance in determining differences between protein levels. Results showed no significant differences in all variables considered. Under this laboratory feeding experiment, the prawns attained weights of 0.95 g (994 percent gain), 0.94 g (921 percent gain), 1.3 g (1417 percent gain), 0.95 g (996 percent gain) and 1.17 g (1263 percent gain) for 20, 25, 30, 35 and 49 percent crude protein levels, respectively in 89 day-culture period.

190. **Antiporda, J.L.** November 1986. Preliminary studies on the effect of methyltestosterone on Macrobrachium rosenbergii juveniles (Crustaceana: Palaemonidae). Bangkok (Thailand). 22 p. Microfiche no: 87X01055.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 86/46.

Macrobrachium rosenbergii juveniles were fed hormone-free and hormone-treated diets at 30 percent crude protein. Methyltestosterone (MT) was incorporated in the diets at 3 levels (25, 75 and 125 mg/kg feed) and administered for 60 days. Growth in all treatments after 30 days post-hormone treatment showed no significant differences ($p<0.05$) while sex ratios were significantly different in three treatments: control v diet I (25 mg MT/kg feed); diet I v diet IV (125 mg MT/kg feed; ($p<0.05$). As artificial control of growth and monosex cultures through hormones are possible tools in any cultural management, this preliminary study may inspire further exploration along these lines particularly on the culture of the giant freshwater prawn.

191. **Boonyaratpalin, M.; Vorasayan, P.** August 1983. Brief note on the state of the art of Macrobrachium culture in Thailand. Bangkok (Thailand). 11 p. Microfiche no: 86X01395.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 83/7.

Current practices in the culture of Macrobrachium in Thailand are reviewed examining hatcheries and grow-out operations, including feeds and feeding.

192. **Chow, K.W.** March 1983. Consultancy report for the initiation of a programme for fish feed development in the Regional Lead Centre in Thailand. Bangkok (Thailand). 43 p. Microfiche no: 86X01396.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 82/5.

The report summarizes the activities of a consultancy on fish feed development in Thailand, including the formulation of a research programme for the development of diets for the pond culture of Clarias and Ophiocephalus (Channa). Information is also presented on the status of the Thai feed milling industry, feed ingredient availability, the establishment of a diagnostic laboratory for nutritional diseases, the mineral requirements of Macrobrachium, and concerning the use of encapsulated whole egg diets for fish larvae.

193. **Ding, J.; Guo, X.; Fang, X.; Liu, M.** January 1987. Preliminary studies on the effects of animal manure on bacterial disease of fish. Bangkok (Thailand). 9 p. Microfiche no: 301315.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 87/49.

The findings are presented of a study conducted to investigate the effects of manure application in fish ponds on bacterial diseases of fish, considering in particular Aeromonas and Pseudomonas. Observations were also made regarding the occurrence of these bacteria in the manure, the pond water and on the fish skin mucus. Results show that although animal manure does not directly cause bacterial diseases in fish, the rate of pathogenic bacteria on the fish skin has a close relationship with that in the pond water. Should the fish resistance to disease be low, there is the possibility of the occurrence of bacterial disease. Careful pond management is required in order to prevent bacterial disease.

194. **Edwards, P.** October 1981. Report of consultancy at the Regional Lead Centre in China for integrated fish farming. Bangkok (Thailand). 106 p. Microfiche no: 86X01207.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 82/6.

Details are given of a study on integrated farming systems in China. Following an indepth examination of the data on existing systems of commercial operations (including recommended procedures for data collection), full lecture notes are presented on the utilization of animal and

plant wastes in aquaculture. An outline is also given of experimental work approaches on integrated farming using tanks and earth ponds.

195. **Guo, X.; Fang, Y.; Wang, J.; Fang, X.; Liu, Z.** 1985. A preliminary study on the nutrient sources for fish growth in manured pond as indicated by delta C analysis. Bangkok (Thailand). 13 p. Microfiche no: 295187.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 85/20.

In a manured fish pond, the conversion of manure-feeds-fish undergoes a complicated process of pond dynamics. In order to understand and manipulate this process and to help us improve farming productivity, we introduced carbon isotope analysis in our experiment. We measured delta C of organic matter, such as fish body, fish feeds, and manure. With this information, we traced the flow of carbon, analyzing the interactions of fish growth and the complicated food web in a manured pond. The data show that filtering and omnivorous species in this manured pond obtained carbon from both autotrophic and heterotrophic production systems. This is of practical significance in planning aquacultural activities and seeking the truth of pond dynamics.

196. **Han, Y.; Ding, J.** November 1986. Comparative study on the effects of fresh and fermented pig manure on fish yield. Bangkok (Thailand). 6 p. Microfiche no: 87X01041.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 86/32.

Pig excreta after biogas fermentation was used as a manure source in fish ponds. After applying fermented manure in fish ponds, the content of quick effective nutritional constituents augmented, resulting in the proliferation and growth of plankton and the improvement of the composition of phytoplankton. Based on the comparative study for 2 years, the fish yield by using fermented manure was 7.1-25.6 higher than that by using fresh pig manure. The increment of feed-eaters is greater than the increment of plankton-feeders. At the same time, the quality of fish has been improved. The synchronous development of livestock-poultry culture, biogas utilization and freshwater aquaculture should be positively encouraged. It could lead to comprehensive utilization of biological resources so as to raise the value of biological resources.

197. **Harimurti, C.** November 1986. The effects of paddlewheel aeration on the pond production of associated natural food organisms under the monoculture system of Macrobrachium rosenbergii de Man. Bangkok (Thailand). 68 p. Microfiche no: 87X01053.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 86/44.

The paper is concerned with the effect of paddlewheel aerators on the production of natural food organisms within ponds stocked with Macrobrachium rosenbergii. The trials were conducted over a six month rearing cycle using four 0.56 hectare ponds stocked with 20 juvenile M. rosenbergii per m^2. Within those duplicate ponds installed with paddlewheel aerators, two 1 HP aerators were employed per 0.56 ha pond, and the aerators operated for three and four hours during the day and night respectively from the fourth to the six month of the experiment only. On the basis of the results obtained the paddlewheel aerators had no apparent effect on plankton growth or on the biomass of benthic organisms within the ponds. The production and species composition of natural food organisms within experimental ponds over the course of the culture trial is analysed in detail, including analyses of prawn stomach contents, and observations on prawn growth presented. It was recommended that the profitability of prawn culture enterprises could be increased and the negative effects of algal blooms eliminated by the stocking of planktivorous fish species.

198. **Hu, B.; Wu, T.; Fang, Y.; Ding, J.; Guo, X.** October 1983. Preliminary studies on the effects of three animal manures on the ecological conditions of pond water and fish growth. Bangkok (Thailand). 13 p. Microfiche no: 86X01393.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 83/9.

A study was conducted in China to determine the independent contribution of three animal manures to changes in the ecological condition of pond water and fish production using carps and tilapias in polyculture. Changes in the pond dynamics and the effects of the manure on the fish growth are described.

199. **Hu, B.; Yang, H.** December 1984. Integrated management of fish-cum-duck farming and its economic efficiency and revenue. Bangkok (Thailand). 7 p. Microfiche no: 301269.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 84/14.

A brief account is given of fish-cum-duck practices in China, considering in particular their economic efficiency and revenue. Three types of farming practices exist: 1) raising large groups of ducks in open water, 2) raising ducks on pond shore, and 3) raising ducks on surfaces of fish ponds.

200. **Hu, B.; Yang, H.** December 1984. The integration of mulberry cultivation, sericulture and fish farming. Bangkok (Thailand). 11 p. Microfiche no: 301267.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 84/13.

The integration of mulberry cultivation, silkworm rearing and fish farming in China is discussed, describing a model for the stocking of a mulberry plot-fish pond ecosystem.

201. **Hu, B.; Yang, M.** December 1984. The characteristics of integrated fish farming in China. Bangkok (Thailand). 9 p. Microfiche no: 86X00878.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 84/12.

The development of integrated fish farming practices in China is discussed. Various ways of recycling organic wastes in the system are described and polyculture systems outlined.

202. **Kungvankij, P.** November 1984. Overview of penaeid shrimp culture in Asia. Bangkok (Thailand). 29 p. Microfiche no: 86X00877.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 84/11.

An account is given of the present status regarding shrimp culture in Asia, describing hatchery design, operation and management, and pond culture systems. The investment of shrimp culture aquaculture in Asia is examined and constraints to shrimp culture development, including larval and compound feed development, detailed.

203. **Kungvankij, P.** November 1985. Researches on marine finfish and shrimp farming. Bangkok (Thailand). 52 p. Microfiche no: 86X00886.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 85/27.

The paper reviews the research activities of the NACA Regional Lead Centre in the Philippines on marine finfish (Asian seabass and grouper) and shrimp (Penaeus monodon/P. indicus) farming. The research infrastructure and facilities are described and the research activities summarized, including feeding trials undertaken with marine shrimp larvae and postlarvae, hatchery live food production, and larval feeding methods for seabass and grouper.

204. **Kungvankij, P.; Pudadera, B.J.; Tiro, L.B.; Potestas, I.O.** June 1986. Biology and culture of sea bass (Lates calcarifer). Selected publication no. 3 for commemorating World Food Day. Bangkok (Thailand). 78 p. Microfiche no: 87X01675.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Training Manual Series 3.

Information is presented regarding the biology and culture of Lates calcarifer in order to serve as a practical guide for extension workers and farmers. Hatchery design, seed production and hatchery techniques, culture of seabass and financial aspects of the seabass culture industry, including feeds and feeding, are described.

205. **Kungvankij, P.; Tiro, L.B.; Pudadera, B.J.; Potestas, I.O.; Chua, T.E.** June 1986. An improved traditional shrimp culture technique for increasing pond yield. Selected publication no. 5 for commemorating World Food Day 1986. Bangkok (Thailand). 18 p. Microfiche no: 87X01677. Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Technology Series 5.

Details are given of findings of shrimp culture studies conducted in earthen ponds in the Philippines using tidal energy for water replenishment and maintenance of water quality. Grow-out facilities, seed supply and operational and management procedures involved, including pond fertilization and feeding methods, are described. A cost/benefit analysis of the technique is presented. It is concluded that the new method is a technically and economically viable technology which may increase production by 2.5-3 fold.

206. **Li, K.** September 1986. A review of rice-fish culture in China. Bangkok (Thailand). 13 p. Microfiche no: 87X01039.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 86/30.

The economic significance of fish culture in paddy fields in China is discussed, and a description given of the preparation for rice-fish aquaculture. Rice fish aquaculture is classified into two types: rice-fish culture in rotation and rice-fish culture in mixed farming. Management of rice-fish aquaculture is examined and discussed.

207. **Mohanty, S.N.; Swamy, D.N.** August 1986. Enriched conventional feed for Indian major carps. Bangkok (Thailand). 8 p. Microfiche no: 87X01037.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 86/28.

The conventional fish feed comprising a 1:1 mixture of groundnut oilcake and rice bran by weight was enriched by incorporation of an aquatic weed, (Salvinia sp.) powder, bloodmeal and sugar wastes and two test diets were prepared with a protein level of 28-29. Diet A comprised bloodmeal, rice bran and groundnut oilcake (1:3:6) while diet B comprised of groundnut oilcake, Salvinia powder and sugar wastes (8:1:1). All the experimental diets were fortified with vitamins and minerals. The two diets were tested against the conventional feed mixture in a laboratory trial-run of 60 days on fry (0.49 g average weight) of Labeo rohita. The significant growth performance ($p<0.01$) was observed in the feed with bloodmeal (0.8 g average live weight gain at a specific growth rate of 1.75 percent of body weight/day) as compared to the other two diets (0.45 g average live weight gain at a specific growth rate of 0.97 percent of body weight/day for the diet incorporating aquatic weed, Salvinia sp. and sugar wastes (diet B) and 0.44 g average live weight gain at a specific growth rate of 1.08 percent of body weight/day for the conventional feed mixture).

208. **Network of Aquaculture Centres in Asia (NACA).** October 1983. Investigation of integrated fish farming in Holei Fish Farm, Wuxi, China. Bangkok (Thailand). 11 p. Microfiche no: 86X01392. Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 83/10.

Findings are presented of a survey of integrated fish farming practices at Holei Fish Farm in Wuxi, China. The significance of water hyacinth fish farming and its appraisal, fish-cum-pig integration and economic benefits, fish-cum-cow integration and economic benefits, and fish-cum-duck integrated systems are described.

209. Olah, J.; Sinha, V.R.P.; Ayyappan, S.; Purushothaman, C.S.; Radheyshayam, S. September 1987. Primary production and fish yields in fish ponds under different management practices. Bangkok (Thailand). 13 p. Microfiche no: 88X01050.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 87/62.

The primary production of fish production patterns in temperate and tropical ponds under different management practices are described. An attempt is made to understand the relation between the two under the given conditions. With a more or less narrow range of primary production, varying fish production and conversion efficiencies were recorded, indicating the influence of a combination of environmental and management factors. The constraints involved in establishing the relationship are discussed.

210. Olah, J.; Sinha, V.R.P. November 1986. Energy cost in carp farming systems. Bangkok (Thailand). 6 p. Microfiche no: 87X01044.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 86/35.

An energy cost analysis is made of various carp farming systems in India and Hungary. Farming in ponds without supplementary feed and fertilizer and sewage-fed ponds were found to be the best systems requiring the lowest amount of energy.

211. Olah, J.; Sinha, V.R.P.; Ayyappan, S.; Purushothaman, C.S.; Radheyshayam, S. August 1987. Community metabolism in tropical undrainable rural fish ponds. Bangkok (Thailand). 7 p. Microfiche no: 88X01049.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 87/61.

The process of community metabolism including primary production and community respiration in eighteen undrainable rural fish ponds in India was quantified using the diurnal oxygen curve method. A considerable portion of the gross primary production that was in the moderate ranges was consumed for the community respiration. Negative and low positive values of net primary production indicated the significance of the allochthonous supply in these organic enriched systems. The low values of sediment respiration signified the reduced condition of stagnating sediment acting as an energy trap.

212. Shan, J.; Chang, L.; Gua, X.; Fang, Y.; Shu, Y.; Zhou, Xiaoxing; Zhou, E.; Schroeder, G.L. December 1984. Observation on feeding habits of fish in ponds receiving green and animal manures in Wuxi, China. Bangkok (Thailand). 10 p. Microfiche no: 86X00879.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 84/16.

Fish yields and ratios of naturally occurring stable carbon isotopes, 13C:12C (reported as delta C) from 1 mu (670m^2) and 5 mu (3330 m^2) ponds were measured. The ponds received daily inputs of green and animal manures as the sole organic inputs. Fish yields exceeding 40 kg/ha per day were attained in both the small and large ponds. Delta C data indicated a strong contribution of the fresh fluid pig manure to growth of the two filter-feeding species, silver and bighead carp. Two grass-eating species, grass carp and Wuchang fish (Megalobrama amblyscephola), had significantly different delta C values, indicating partially separate food sources for each of these two species.

213. Shan, J.; Chang, L.; Gua, X.; Fang, Y.; Zhu, Y.; Zhou, Xiaoxing; Zhou, E.; Schroeder, G.L. September 1983. Some observations on fish feeding in integrated fish farming ponds based on delta C analyses of fish flesh and natural foods. Bangkok (Thailand). 11 p. Microfiche no: 86X01394.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 83/8.

The use of delta C analysis to monitor the feeding pattern of Chinese carps and tilapia (nilotica x aurea) within integrated fish ponds is described. Data is presented on the relative contribution of manures, exogenous feeds and natural pond food organisms to the overall nutritional budget of the different cultured fish species.

214. **Sinha, V.R.P.** September 1985. Integrated carp farming in Asian country. Bangkok (Thailand). 19 p. Microfiche no: 86X00884.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 85/25.

Asia has been the cradle of integrated crop-livestock-fish (mainly carp) farming systems, which evolved by themselves since the inception of human civilization particularly when the human settlements started moving inland leaving the river banks. To meet their water requirements they started constructing rain or flood fed water retention/detention structures which formed the nucleus of such integration. Based on the empirical knowledge of the farmers, the systems have a history of over two millennia in parts of soutn and southeast Asia. However, the importance of the systems has been realized of late, the scientific bases of which are being investigated to evolve proper technologies to get optimum productivity of the land, labour, waste and water. The systems help poor fishermen and small farmers having too small holding for crop production and a few heads of livestock to diversify their farm production, increase cash income, improve quality and quantity of food produced and exploitation of unutilized resources. The paper enumerates different carp integrated farming systems in Asia along with certain successful case studies indicating potentiality and constraints of such systems. On the basis of which it is recommended that utmost emphasis is needed to integrated carp farming with agriculture and irrigation, livestock farming, sewage utilization and water pollution control not only to increase the productivity of land and water and improve the economic conditions of poor farmers but also to maintain health and hygiene of the rural poor and city dwellers.

215. **Tripathi, S.D.; Mishra, D.N.** August 1986. Synergistic approach: an alternative to high-cost aquaculture. Bangkok (Thailand). 12 p. Microfiche no: 87X01038.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 86/29.

The package of modern aquaculture practices involve high-cost technologies. However, there is an increasing awareness towards development of low-cost, energy-saving, systems and several efforts have been directed toward achieving this goal during the recent past. Measures such as reduction in the rate of stocking densities and elimination of the feed component have been adopted coupled with low/reduced targets of production. In addition, to these known approaches, a novel synergistic approach has been adopted with high targets of production in the experiments conducted at the Jaunpur Centre of the All India Coordinated Research Project on Composite Fish Culture and Fish Seed Production. Using either phosphatic or nitrogenous fertilizers and aquatic weeds, yields of the order of 2,609-3,300 and 3,642-3,966 kg/ha in 9 months have been realised at input costs of Rs 1.13 - Rs 1.77 (US$ 0.09 - 0.15) but even higher yields ranging from 4,074 kg/ha/9 months to 4,480 kg/ha/year have been obtained with aquatic weeds alone at a remarkably low input costs of Rs 0.93 - Rs 1.42 (US$ 0.08-0.12) per kilogram of fish suggesting that the newly developed, low cost, labour intensive, technology could be recommended for extensive adoption in the rural areas, especially in the Third World where submerged aquatic vegetation such as Hydrilla, Potamogeton and Ceratophyllum or terrestrial vegetation like grasses or fodder are abundantly available.

216. **Yang, Yejin; Zhu, Y.; Hua, D.; Wan, J.** February 1987. Studies on the effects of fresh and fermented manure on fish production. Bangkok (Thailand). 8 p. Microfiche no: 88X01046.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 87/52.

A comparative study was undertaken to determine the effects of fresh and fermented pig manure, as compared with a control chemical fertilizer, on fish production (polyculture of silver, bighead, crucian and common carp) within earthen ponds in China. The results indicated that fish

production was highest in ponds receiving fresh pig manure and lowest within chemically fertilized ponds. It was suggested that fish production was highest within ponds fertilized with fresh manure because in contrast to the other treatments the fish could feed directly on the manure particles.

217. **Zhu, Y.; Yang, Yejin; Wan, J.; Hua, D.** January 1987. Primary studies on frequencies of fertilization of fish ponds. Bangkok (Thailand). 13 p. Microfiche no: 88X01045.
Project: RAS/76/003 - Establish Network of Aquaculture Centres in Asia. NACA Working Paper 87/50.

Details are given of experiments conducted investigating methods of manuring and/or fertilizing fish ponds and effects on fish yields. Fermented pig manure and chemical fertilizers are given in different treatments to ponds stocked with carp species. Daily manured ponds showed 30-40 percent higher fish yields than those manured at 5-day and 7-day intervals. Daily application of manure was found to raise the efficiency of conversion of manure into fish body protein, thus leading to higher fish yields.

ESTABLISHMENT OF NETWORK OF AQUACULTURE CENTRES IN ASIA

218. **Chen, Y.** 1989. Animal raising and plant cultivation on an integrated fish farm. Integrated fish farming in China. A World Food Day 1989 publication of the Network of Aquaculture Centres in Asia and the Pacific. Bangkok (Thailand). p. 217-254. Microfiche no: 300725-745.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Technical Manual 7.

The paper discusses animal raising and plant cultivation methods used within integrated fish farms, including sericulture, chicken farming, goose production, duck production, pig farming, milk cow production, earthworm production, and the cultivation of pasture grass, beans, grains, sweet potato, cabbage and melons, squash, and aquatic plants.

219. **Ding, J.; Guo, X.; Fang, X.; Liu, M.; Zhang, W.** December 1988. Preliminary studies on the effect of livestock manure application on bacterial fish disease and human hygiene. Bangkok (Thailand). 12 p. Microfiche no: 289613.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Working Paper 88/69.

An investigation on the effect of application of livestock manure, the biomass of aerobic heterotrophic bacteria and Colicin population and distribution of Aeromonas, Pseudomonas and pathogenic bacteria of the human digestive tract which are also present in the body mucus of black carp, grass carp, silver carp and bighead carp as well as in pond water (on the application of manure of chicken, duck, cow and pig) was conducted in the fish farming areas in Wuxi, China. The results show less frequency of fish pathogenic bacteria in the four kinds of manure. Aeromonas and Pseudomonas population were, however, higher in the manured pond water than in the non-manured pond. Although there was less amount of fish pathogenic bacteria in the animal manure, body mucus of black carp and grass carp which dwell in the pond bottom and mid-level can cause the occurrence of Pseudomonas (one of the pathogens of Stigamatosis) due to the decomposition of manure on the pond bottom. With the exception of chicken manure in which there was Group E Salmonella, no other pathogenic bacteria was found in the manure of duck, cow or pig. None was found either on the fish body nor in the fish viscera of manure-applied fish ponds. The fish cultured in the manure-applied pond were descaled and washed, the quantity of Colicin was reduced by 100-1000 times, the concentration of which was almost the same as that in the manure-free pond. Results indicated that the fish cultured within manure-fed ponds were hygienic as human food and not harmful to human health after treatment by washing.

220. Fang, Y.; Guo, X.; Wang, J.; Yang, Yejin; Yang, Yaping; Liu, Z. December 1988. Effects of different animal manures on the ecological factors and fish yield in fish ponds. Bangkok (Thailand). 5 p. Microfiche no: 289609.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Working Paper 88/67.

Different animal manures were used in the experiment; fish (silver carp, bighead carp, common carp and crucian carp) yield within the chicken-manured pond was the highest, followed by that of the duck-manured, pig-manured and cow-manured ponds. The reported factors which affected fish yield were inorganic nitrogen, phosphorus, and phytoplankton and zooplankton biomass.

221. Fei, Y. 1989. Pond culture of food fish. Integrated fish farming in China. A World Food Day 1989 publication of the Network of Aquaculture Centres in Asia and the Pacific. Bangkok (Thailand). p. 87-117. Microfiche no: 300725-745.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Technical Manual 7.

The paper reviews the pond culture of carps and tilapia in China and presents information on the stocking and polyculture of fingerlings; harvesting and stocking in rotation; multiple-grade conveyor culture; shortening the fish-rearing period; management of rearing food fish; and daily routine of pond management. Information is provided within the paper on the feeding of food fish within earthen ponds, including feeding allocation and level, feeding techniques, and manuring.

222. Guo, X.; Fang, Y.; Wang, J.; Fang, X. December 1988. Preliminary studies on the analysis of bacterial types in the fish ponds applied with four kinds of animal manure and the effects of manuring on the ecosystem and yield. Bangkok (Thailand). 16 p. Microfiche no: 289607.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Working Paper 88/66.

The studies consisted of a continuous determination of the composition and change of aquatic bacteria and related ecological parameters in fish ponds applied with four kinds of manure (chicken, duck, pig and cattle), and the analysis of results using mathematical statistics and a mini-computer. The study showed that aquatic bacteria have a very close relationship with many ecological parameters in the fish pond, including dissolved oxygen, BOD, suspended solids, organic detritus, transparency, nutrient salts and plankton, which in turn have either a direct or indirect effect on their existence and growth. It was therefore apparent that aquatic microorganisms have a very strong influence on the pond ecosystem. At the same time, aquatic bacteria, as material decomposers and natural feed for fish, also directly or indirectly effect the pond autotrophic and heterotrophic food chains, and by so doing, in turn, affecting the growth and yield of fish within the fertilized ponds.

223. Janssen, J.; Bhasayavan, N.; Pongsri, C. 1988. Studies on the culture of the freshwater prawn Macrobrachium rosenbergii at various stocking size and density in ricefields. Bangkok (Thailand). 33 p. Microfiche no: 291419.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Working Paper 88/75.

Experiments were conducted to investigate the possibility of prawn culture in ricefields. Plots were prepared for the experiments by digging a trench around the ricefield. Paddy was planted and tillered before the prawn were stocked. Prawn were of two sizes, just metamorphosed postlarvae (PL 1) measuring 1-1.5 cm in length, others as PL 60 measuring 4.5-4.8 cm in length. The latter ones were first nursed for 60 days in ponds before stocking in the ricefield. The PL 1 were stocked at the rate of 1.25/m^2 and PL 60 at 0.31, 0.63 and 1.25/m^2. The size of each of the ricefields in this experiment was about 1600 m^2. After a culture period of 90 to 100 days the prawn were handpicked after draining or pumping the water out of the field. The PL 1 in ricefields grew to 5.4 g after 90 days with 34 percent of the population having an average weight of 17.1 g indicating clearly that the stocked PL grew extremely well in a ricefield ecosystem. The PL 60 grew to an average weight of 16.8 g in 91-100 days in ricefields, but those stocked at a rate of

0.63/m^2 grew up to 45 g with feed and contributed to 53 percent of the production in this field. The difference in growth was not considerable between the three stocking densities. However, the production was higher with higher stocking density. Thus it appears that a stocking density of 1.25 prawn/m^2 seems appropriate for a production potential of 13 g/m^2. Survival rates as high as 89 percent can be expected. The water level in the ricefields needs to be maintained above 30 cm especially after the tillering of rice. Fencing material on the dikes and screening material at the outlet and inlet need to be strong to ward off predatory fishes. The results show that a high rice plant density has adverse effects on the survival rate of the prawn. Thus the present investigation shows that the ricefield can be used as nursery ground for prawn PL 1. Also the PL 60 can be raised in ricefields in concurrent cultivation with prawns with about half of them reaching marketable size within 3 months time, adding to the farmers income. Thus the integrated farming system of rice and prawn has potential to increase the farmers income.

224. **Minh, K.** 1988. An economic appraisal of "bamboo plot-fish" farming. Bangkok (Thailand). 8 p. Microfiche no: 291411.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Working Paper 88/71.

Fish farming in China is characterized by integration. There are many systems of integration with fish culture to facilitate the maximum utilization of wastes for the production of protein-rich food such as fish. "Bamboo Plot-Fish Pond" is another example of fish farming with a long tradition. The farmers, in Pearl River Delta particularly, have gained age-old experiences and found that the economic returns are high and the inputs low with this farming system. The bamboo shoots are sold to the market as food. Processing the bamboo shoots into canned food provides 25-30 percent by-products which can be utilized as food or pond manure. The space between rows of the bamboo shoots can be used for cabbage production which can satisfy the food needs of 85-90 percent of the fish at a production rate of 250 kg/mu.

225. **New, M.B.** 1988. Freshwater prawns: status of global aquaculture, 1987. Bangkok (Thailand). 62 p. Microfiche no: 89X01078-E.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Technical Manual 6.

Though the farming of freshwater prawns (Macrobrachium spp.) forms only about 6 percent of the global aquaculture production of shrimps and prawns it is of considerable local importance particularly in Thailand and Taiwan. Farmed freshwater prawns are now entering global, as well as domestic markets, a development likely to stimulate renewed interest in Macrobrachium culture in other tropical countries. This review summarizes the status of freshwater prawn culture globally in 1987 in terms of rearing technology, including feeds and feeding, marketing and economics.

226. **Shan, J.; Wu, S.** December 1988. Effects of green manure on fish production in polyculture ponds with silver carp and bighead carp as main species. Bangkok (Thailand). 4 p. Microfiche no: 289603.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Working Paper 88/64.

Four types of green manure were used in the polyculture ponds with silver carp and bighead carp as the main species. Direct application of green manure resulted in higher fish production ranging from 19.59 to 25.33 kg/ha/day. Sudan grass was best among four types of green manure.

227. **Shi, W.; Shan, J.; Liu, M.; Yan, H.; Huang, F.; Zhou, Xiaowei; Shen, L.** December 1988. A study on the optimum demand of protein by blunt-snout bream (Megalobrama amblycephala). Bangkok (Thailand). 5 p. Microfiche no: 289611.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Working Paper 88/68.

A brief account is given of studies conducted on the optimum demand of protein by blunt-snout bream (Megalobrama amblycephala) in pond culture systems. Findings show that at a water temperature of 20°C the range of optimum demand of protein in feeds is 27-30 percent; at 25-30°C the range is between 25-41 percent. Data are also presented regarding the effect of the protein composition of feeds on the protein and fat composition of fish flesh and the biochemical index of blood.

228. **Yang, H.; Hu, B.** 1989. Introduction of Chinese integrated fish farming and some major models. Integrated fish farming in China. A World Food Day 1989 publication of the Network of Aquaculture Centres in Asia and the Pacific. Bangkok (Thailand). p. 153-196. Microfiche no: 300725-745.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Technical Manual 7.

The paper discusses Chinese integrated fish farming systems under the following headings: 1) advantages of integrated fish farming, 2) the characteristics of Chinese integrated fish farming, including methods for organic waste utilization, 3) integrated management of fish and crop farming, including feed demand fish farming, 4) integrated management of fish-livestock-poultry farming, including manure composition, application and natural food productivity, 5) models of fish-livestock-crop integration, including utilization of primary productivity, and 6) web of integrated management.

229. **Yang, Yejin; Zhu, Y.; Hua, D.; Wan, J.** December 1988. Preliminary studies on the effects of fresh and fermented pig manure on fish production. Bangkok (Thailand). 9 p. Microfiche no: 289605.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Working Paper 88/65.

The growth of several cultivated fishes of Cyprinidae was studied using cognate fresh and fermented pig manure and the equivalent fertilizers N and P as sole inputs to different experimental groups of fish ponds. Experiment I was conducted from June to October 1986, experiment II from March to October 1987. The proportions of fish production from chemical-fertilized ponds (C), fermented pig manured ponds (F1), and fresh pig manured ponds (F2) were 100:156:226 and 100:294:382 respectively. The ratio of fish production of F1 ponds to F2 ponds was 100 to 145 in experiment I and 100 to 130 in experiment II, respectively. The chlorophyll content, zooplankton biomass, bacterial activity and BOD were lower in the C ponds than in the F1 and F2 ponds, while the DO concentration was higher. There was little difference in the concentration of NH4-N and PO4-P among the experimental ponds. The physico-chemical parameters in the F1 and F2 ponds were not always in conformity with the fish production. Some parameters were contradictory in these two experiments. In experiment I the content of NH4-N in F1 ponds was lower than in the F2 ponds, and the content of chlorophyll and zooplankton biomass in F1 ponds greater than that within F2 ponds. By contrast, all three parameters were reversed during experiment II within F1 and F2 ponds. These results indicate that part of the fish production in the C ponds came from the natural planktonic food chain, while in the F1 and F2 ponds, much of the production was derived from the manure detritus as well as from the planktonic food chain. The nutrient value of fermented pig manure is probably less than that of fresh manure because of bacterial decomposition during fermentation. There is a complicated relationship among various physico-chemical factors after manure application in the F1 and F2 ponds. During the experiments, it was found that the application of fresh pig manure did not cause any fish diseases; it was not found necessary therefore to ferment pig manure before application.

230. **Yu, S.** 1989. Pond fertilization and fish feeds. Integrated fish farming in China. A World Food Day 1989 publication of the Network of aquaculture Centres in Asia and the Pacific. Bangkok (Thailand). p. 51-69. Microfiche no: 300725-745.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Technical Manual 7.

The paper is divided into two parts. The first part deals with pond fertilization, including the significance of pond fertilization in China, varieties of organic manures, methods of manure application, effects of manure application on natural food organisms, varieties of inorganic manures, and methods of inorganic manure application. The second part of the paper deals with fish feeds, including the significance of feeding, requirements for different nutrients, evaluation of nutritional value of fish feeds, and varieties of fish feeds.

231. **Zhu, L.** 1989. Rearing of fry and fingerlings. Integrated fish farming in China. A World Food Day 1989 publication of the Network of Aquaculture Centres in Asia. Bangkok (Thailand). p. 71-86. Microfiche no: 300725-745.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Technical Manual 7.

The paper discusses the rearing methods employed in China for rearing carp fry and fingerlings and is presented under the following headings: 1) biology of fry and fingerlings; 2) choice of ponds and pond clearing; 3) rearing of fry and fingerlings, including manuring and feeding practices and schedules.

232. **Zhu, Y.; Ye, J.Y.; Wan, J.; Hua, D.** December 1988. Preliminary studies on the effects of frequencies of manure application on fish yield (Abstract). Bangkok (Thailand). 1 p.
Project: RAS/86/047 - Establishment of Network of Aquaculture Centres in Asia. NACA Working Paper 88/70.

The growth of several cultivated cyprinid fish species was studied using fermented pig manure as the sole input at different frequencies. Eight experimental ponds divided into four groups (P1, P2, P3 and P4) and each group consisting of two ponds were used in the experiment. P1 received only chemical fertilizers (equivalent N and P) once a week as the control group, while fermented pig manure was applied to P2 once every five days, to P3 once a week, and to P4 once a day. Each pond finally received the same amount of fertilizer during the experimental period. The two experiments were conducted from June to October 1986 and March to October 1987, respectively. The results of the two experiments showed that a higher fish yield could be achieved by increasing the frequency of fertilizer application. The fish production from P4 was 30-40 percent higher than that in P3 and P2. According to the biological and physico-chemical parameters, the reason for increasing fish yield in P4 was considered that the daily addition of a fixed quantity of manure into fish ponds results in a continuous supply of nutrients to the plankton and bacteria in the pond and this favouring the growth of fish. Fish can utilize the undigested components of pig manure, in addition to the digested parts in cotton-like aggregates with bacteria.

REGIONAL SEAFARMING DEVELOPMENT AND DEMONSTRATION PROJECT

233. **Regional Seafarming Development and Demonstration Project.** September 1988. Training manual on marine finfish netcage culture in Singapore. Prepared for the marine finfish netcage culture training course conducted by the Primary Production Department of the Republic of Singapore. 295 p. Microfiche no: 291651.
Project: RAS/86/024 - Regional Seafarming Development and Demonstration Project.

The manual is divided into nine parts and covers the following topics in detail namely: 1) overview of marine aquaculture development in Singapore, 2) netcage construction, 3) the raft structure, 4) the netcage operation and maintenance, 5) site selection, 6) species selection, culture and economics, 7) nutrition and feeds, 8) fish health and diseases, and 9) live fish transportation.

234. **Cuzon, G.** February 1989. Feasibility study for producing pelleted shrimp feed in Fiji. Suva (Fiji). 26 p.
Project: GCP/RAS/116/JPN - Regional South Pacific Aquaculture Development Programme. Field Document 90/3.

The report describes the findings of the consultant concerning the feasibility of producing feeds based on locally available ingredients for semi-intensive shrimp culture in Fiji, and is presented under the following headings: 1) survey of existing facilities for shrimp feed processing and outline of past activities in Fiji, 2) economic study for shrimp feeds, including marine shrimp (Penaeus monodon) and freshwater prawn (Macrobrachium sp.) production, and 3) recommendations to the project for a research programme on feed preparation and for the manufacture of economically viable shrimp feed.

235. **Garcia, L.M.B.** 1990. Fisheries biology of milkfish (Chanos chanos Forskal). Proceedings of the Regional Workshop on Milkfish Culture Development in the South Pacific, Tarawa (Kiribati), 21-25 November 1988. Edited by H. Tanaka, K.R. Uwate, J.V. Juario, C-S. Lee & R. Foscarini. Suva (Fiji). p. 66-76.
Project: GCP/RAS/116/JPN - Regional South Pacific Aquaculture Development Programme. Field Document 90/5.

The paper reviews the fisheries biology of milkfish (Chanos chanos), including taxonomic classification, distribution, life history and habitat, food and feeding habits, growth, reproduction, and tolerance to environmental conditions.

236. **Juario, J.V.** 1990. Milkfish culture in the Philippines. Proceedings of the Regional Workshop on Milkfish Culture Development in the South Pacific, Tarawa (Kiribati), 21-25 November 1988. Edited by H. Tanaka, K.R. Uwate, J.V. Juario, C-S. Lee & R. Foscarini. Suva (Fiji). p. 88-97.
Project: GCP/RAS/116/JPN - Regional South Pacific Aquaculture Development Programme. Field Document 90/5.

The paper reviews milkfish (Chanos chanos) culture in the Philippines and covers issues such as management intensity, pond preparation, natural food production, stocking practices, water management, supplemental feeding, grow-out culture, harvest, and fishpen culture.

237. **Lee, C-S.; Banno, J.E.** 1990. Milkfish culture and production in Southeast Asia - present and future. Proceedings of the Regional Workshop on Milkfish Culture Development in the South Pacific, Tarawa (Kiribati), 21-25 November 1988. Edited by H. Tanaka, K.R. Uwate, J.V. Juario, C-S. Lee, & R. Foscarini. Suva (Fiji). p. 43-65.
Project: GCP/RAS/116/JPN - Regional South Pacific Aquaculture Development Programme. Field Document 90/5.

The paper gives an overview of milkfish culture and production in Southeast Asia, including the culture methods employed in Taiwan, the Philippines and Indonesia. Particular attention is given to the pond preparation and water management techniques employed for the production of natural food organisms within the ponds for the cultured fish. The current problems and future prospects of milkfish culture in the region are discussed.

238. **Tanaka, H.; Uwate, K.R.; Juario, J.V.; Lee, C-S.; Foscarini, R.** (Editors). 1990. Proceedings of the Regional Workshop on Milkfish Culture Development in the Philippines, Tarawa (Kiribati), 21-25 November 1988. Suva (Fiji). 139 p.
Project: GCP/RAS/116/JPN - Regional South Pacific Aquaculture Development Programme. Field Document 90/5.

The proceedings of the workshop on milkfish culture development is presented in two parts: the first part concerning individual country reports for the Cook Islands, Federated States of

Micronesia, Guam, Hawaii, Kiribati, Nauru, Solomon Islands, Palau, Tonga and Tuvalu; and the second part concerning the individual technical papers presented during the workshop, including 1) milkfish culture and production in Southeast Asia, 2) fishery biology of milkfish, 3) milkfish fry collection and handling, 4) milkfish culture in the Philippines, 5) milkfish culture methods in Kiribati, 6) economics of milkfish culture in the Philippines, and 7) economics of milkfish culture in the Pacific Islands.

SMALL-SCALE FISHERFOLK COMMUNITIES IN THE BAY OF BENGAL

239. **Angell, C.** June 1989. Artemia culture in the Bay of Bengal. Madras (India). Bay of Bengal News no. 34. p. 10-13. Microfiche no: 89S90702.
Project: GCP/RAS/118/MUL - Small-scale Fisherfolk Communities in the Bay of Bengal.

The paper reviews the history of Artemia culture in the Bay of Bengal region and in particular reports on the country experience papers presented during a regional workshop in Madras on Artemia culture.

240. **Angell, C.** March 1988. The BOBP (Bay of Bengal Programme) experience in shrimp feed formulation. Madras (India). Bay of Bengal News no. 29. p. 8-11. Microfiche no: 88S90701.
Project: GCP/RAS/118/MUL - Small-scale Fisherfolk Communities in the Bay of Bengal.

The basic nutritional requirements of shrimps are reviewed and problems regarding the preparation of artificial feed for use in culture operations in the Bay of Bengal area are examined. Some practical diet formulations are summarized; future improvements in the productivity of the shrimp culture industry in countries of the region depend on the development of national and regional feed manufacturing capabilities.

241. **Bostock, T.** June 1991. Better feeds for small-scale shrimp farmers. Madras (India). Bay of Bengal News no. 42. p. 22-26.
Project: GCP/RAS/118/MUL - Small-scale Fisherfolk Communities in the Bay of Bengal.

The paper discusses some of the results of the BOBP feed and pond management programme concerning the development of shrimp feeds for small-scale shrimp farmers in Andhra Pradesh, India. The traditional methods used for feed preparation by farmers in the area are described together with the present problems of this feeding strategy. In addition, the results of pond feeding trials using diets developed by BOBP are described.

242. **Wood, J.; Brown, J.H.** September 1990. Making high-quality shrimp feed in India: What do intial trials show? Madras (India). Bay of Bengal News no. 39. p. 14-17.
Project: GCP/RAS/118/MUL - Small-scale Fisherfolk Communities in the Bay of Bengal.

The paper discusses the possibilities of producing high quality feeds for tiger shrimp (**Penaeus monodon**) in India. The results of the BOBP semi-intensive pond feeding trials are summarized and indicate that pelleted feed is preferable to dough-ball feed for high shrimp survival and growth.

243. **Wood, J.; Coulter, J.** December 1988. India's expanding prawn culture industry: where will the feed materials come from? Madras (India). Bay of Bengal News no. 32. p. 12-18. Microfiche no: 88S90704.
Project: GCP/RAS/118/MUL - Small-scale Fisherfolk Communities in the Bay of Bengal.

An examination is made of the raw materials available for commercial production of prawn feed in India, considering fish meal, prawn heads, Acetes shrimp, meat from bivalve molluscs and snails, squid waste, squilla and oilseeds. Findings show that there is a clear deficiency in marine protein for prawn feed manufacture in India; the need for the establishment of mechanisms for improving the supply of quality fish meal to the industry is stressed.

SOUTH CHINA SEA FISHERIES DEVELOPMENT AND COORDINATING PROGRAMME

244. **Association of South East Asian Nations (ASEAN).** 1978. Manual on pond culture of Penaeid shrimp. Manila (Philippines). 141 p. Microfiche no: 41740.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Manual ASEAN77/SHR/CUL3.

The manual is presented under 12 major headings namely: 1) suitability of various species for culture, 2) site selection criteria to be evaluated, 3) design criteria required by shrimp, 4) layout, 5) engineering and construction, 6) seed stock, 7) pond management (including water change; pond preparartion; different types of food organisms grown in ponds and their suitability for shrimp culture; recommendations for managing natural food organisms in shrimp ponds; methods of growing the different types of natural food; supplementary feeding; stocking rate), 8) predators, competitors and pests, 9) disease and parasites, 10) indicators of trouble and remedial action, 11) sampling and analysis, and 12) harvesting.

245. **South China Sea Fisheries Development and Coordinating Programme.** October 1982. Report of the Training course on seabass spawning and larval rearing - Regional, Songkhla (Thailand), 1 June 1982. Manila (Philippines). 120 p. Microfiche no: 8329831-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Report SCS/GEN/82/39.

The report includes papers presented at the training course under the following headings: 1) lecture series (19 lectures, including the food and feeding of seabass (Lates calcarifer) larvae and juveniles, and the production of food organisms with particular emphasis on rotifers); 2) practical/field exercises (including growing food organisms and feeding of larvae and juveniles); and 3) Participants' experience reports by country, including Australia, Hong Kong, Indonesia, Malaysia, Philippines, Singapore and Thailand.

246. **Guerrero, R.D.** January 1982. Culture of invertebrates as food organisms for village-level fish hatcheries. Report of the Training Course on Growing Food Organisms for Fish Hatcheries, Iloilo, 3-22 August 1981. Edited by R.D. Guerrero & C.T. Villegas. Manila (Philippines). p. 81-83. Microfiche no: 8227251-263-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Report SCS/GEN/82/37.

A review is presented of some practical methods that may be applied by fish farmers in producing food organisms for fish and prawn hatcheries. Organisms involved in the discussion include Moina, chironomid larvae, mosquito (Culex) larvae and earthworms (Lumbricus).

247. **Guerrero, R.D.; Villegas, C.T.** (Editors). January 1982. Report of the Training Course on Growing Food Organisms for Fish Hatcheries, Iloilo (Philippines), 3-22 August 1981. Manila (Philippines). 233 p. Microfiche no: 8227251-263-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Report SCS/GEN/82/37.

The report contains six working papers namely: 1) culture and screening of food organisms as potential larval food for finfish and shellfish, 2) culture of phytoplankton, 3) culture of zoolplankton (Brachionus and Moina), 4) biology, use and culture of Artemia, 5) yeasts as food organisms in aquaculture, and 6) culture of invertebrates as food organisms for village-level fish hatcheries. In addition the report presents practical exercises related to the production and use of live food organisms together with country/agency experience reports from Bangladesh, Burma, Fiji, India, Indonesia, Kuwait, Malaysia, Philippines, Singapore, Sri Lanka and Vietnam.

248. **Hechanova, R.G.; Tiensongrusmee, B.** April 1980. Report of assistance on selection of site, design, construction and management of the Ban Merbok, Kedah, Malaysia brackishwater aquaculture demonstration project, Malaysia. Manila (Philippines). 163 p. Microfiche no: 8003741-E.

Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Working Paper SCS/80/WP/88.

The report is presented under the following headings: 1) selection of fishpond site, 2) design of fishpond project, 3) general guidelines for the operation and management of fishponds, including pond preparation, application of fertilizers and supplementary feeding, 4) multipurpose hatchery for penaeid shrimp and finfish, 5) construction of fish pond, 6) plan of hatchery operation, 7) problems and constraints of recommended solutions, and 8) estimate of costs.

249. **Jumalon, N.A.; Figueroa, R.F.; Mabaylan, A.G.; Estenor, D.G.** January 1982. Biology, use and culture of Artemia. Report of the Training Course on Growing Food Organisms for Fish Hatcheries, Iloilo, 3-22 August 1981. Edited by R.D. Guerrero & C.T. Villegas. Manila (Philippines). p. 59-75. Microfiche no: 8227251-263-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Report SCS/GEN/82/37.

The use and importance of Artemia in aquaculture is discussed in detail. Following an outline of the biology (systematic classification, life cycle, modes of reproduction), the quality evaluation, decapsulation and hatching of Artemia cysts are considered. Indoor and saltpond culture are discussed.

250. **Maneewongsa, S.; Tattanon, T.** October 1982. Food and feeding of seabass larvae and juveniles. Report of the Training Course on Seabass Spawning and Larval Rearing, Songkhla (Thailand), 1-20 June 1982. Manila (Philippines). p. 25. Microfiche no: 8329831-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Workshop Report SCS/GEN/82/39.

Food organisms and food sources of seabass (Lates calcarifer) larvae are described. The larvae feed mainly on rotifer (Brachionus plicatilis) initially followed by brine shrimp (Artemia) and Daphnia or Moina. The method of feeding to be used is outlined.

251. **Manik, R.** December 1980. Formulated feeds for freshwater prawn Macrobrachium rosenbergii. Report on the Training Course on Prawn Farming for Asia and the Pacific, Jepara, Central Java, Indonesia, 5 October - 15 November 1980. Edited by V. Soesanto, S. Adisukresno & G.L. Escritor. p. 65-81. Microfiche no: 8215559-585-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Workshop Report SCS/GEN/81/28.

The paper reviews the dietary nutrient requirements of freshwater prawns and describes the steps involved in diet formulation, feed processing and storage, and feeding. Examples of larval and grow-out feed formulations are presented.

252. **Martosudarmo, B.** December 1980. Culture of food organisms. Report on the Training Course on Prawn Farming for Asia and the Pacific, Jepara, Central Java, Indonesia, 5 October - 15 November 1980. Edited by V. Soesanto, S. Adisukresno, & G.L. Escritor. p. 61-63. Microfiche no: 8215559-585-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Workshop Report SCS/GEN/81/28.

The paper is concerned with the role of algae, and in particular Chlorella sp., as food organisms for the culture of macrobrachium larvae. The procedure for producing chlorella within a 5-ton tank is described.

253. **Mok, T.K.** January 1982. Feeds and feeding fishes in cages. Training Course on Small-Scale Pen and Cage Culture for Finfish. Report, Laguna (Philippines), Aberdeen (Hong Kong), 26 October 1981. Manila (Philippines). p. 115-118. Microfiche no: 8226159-197-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Report SCS/GEN/82/34.

Fish in cage culture must receive their nutrients and energy from food. Prepared feeds offer a number of advantages over natural food, the most important being the fact that they are relatively uniform in composition and the ingredient content of the diet can be altered to adapt the feed to the specific needs of the species of fish. The composition and formulation, physical properties and manufacture of artificial feeds are described and feeding practices outlined.

254. **New, M.B.** December 1979. Report of consultancy on the fish and crustacean nutrition programme at the Changi Marine Fisheries Research Centre, Primary Production Department, Singapore. 28 p. Microfiche no: 8002343-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Working Paper 79/85.

The report is concerned with the discussions of the consultant with the Changi Marine Fisheries Research Centre on the development of fish nutritional studies for marine finfish (i.e. Epinephelus sp., Lates calcarifer), including: high protein ingredients; binders; ration formulation; analytical control of diets; experimental design and systems for diet testing; future dietary experimental programme; tour of fish nutrition laboratories; laboratory layout; animal feedstuff manufacture and equipment; biological filtration and recirculation systems; and light.

255. **Sungkasem, P.** October 1982. The economics of seabass production. Report of Training Course on Seabass Spawning and Larval Rearing, Songkhla (Thailand), 1-20 June 1982. Manila (Philippines). p. 53-58. Microfiche no: 8329831-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Workshop Report SCS/GEN/82/39.

The economics and profitability of the hatchery production and grow-out culture of seabass (Lates calcarifer) in Thailand is described, including an analysis of food and feeding costs.

256. **Tech, E.** January 1982. Culture of phytoplankton. Report of the Training Course on Growing Food Organisms for Fish Hatcheries, Tigbauan, Iloilo (Philippines), 3-22 August 1981. Edited by R.D. Guerrero & C.T. Villegas. Manila (Philippines). p. 25-34. Microfiche no: 8227251-263-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Workshop Report SCS/GEN/82/37.

The culture of phytoplankton for use as feed for fish and shrimp is discussed, including ecological importance, potential, sampling and isolation (including a description of biological and mechanical isolation techniques), and growth and the factors affecting growth.

257. **Tech, E.** January 1982. Culture of zooplankton. Report of the Training course on Growing Food Organisms for Fish Hatcheries, Tigbauan, Iloilo (Philippines), 3-22 August 1981. Manila (Philippines). p. 35-57. Microfiche no: 8227251-263-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Workshop Report SCS/GEN/82/37.

The culture of Brachionus plicatilis and Moina macrocopa are described in detail. The following aspects are considered: 1) taxonomy, 2) general description, 3) distribution, 4) potential, 5) food and feeding, and 6) culture methods.

258. **Villegas, C.T.** January 1982. Culture and screening of food organisms as potential larval food for finfish and shellfish. Report of the Training Course on Growing Food Organisms for Fish Hatcheries, Iloilo (Philippines), 3-22 August 1981. Edited by R.D. Guerrero & C.T. Villegas. Manila (Philippines). p. 9-23. Microfiche no: 8227251-263-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Workshop Report SCS/GEN/82/37.

The culture of food organisms for fin and shellfish larvae is discussed in detail. Some of the artificial and enriched media that have been developed and tested for microalgae culture are enumerated and some isolation methods are given. Culture methods for phytoplankton and

zooplankton are described. The screening, evaluation, nutritive value and suitability of food organisms are considered and some criteria for the selection of food organisms and best food conditions for larvae are presented.

259. **Villegas, C.T.** January 1982. Yeasts as food organisms in aquaculture. Report of the Training Course on Growing Food Organisms for Fish Hatcheries, Tigbauan, Iloilo (Philippines), 3-22 August 1981. Edited by R.D. Guerrero & C.T. Villegas. Manila (Philippines). p. 77-80. Microfiche no: 8227251-263-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Workshop Report SCS/GEN/82/37.

The paper reviews the use of yeasts in aquaculture as a food source for the mass culture of the rotifer Brachionus plicatilis and copepod Tigriopus japonicus and as a direct food source for Penaeus japonicus larvae and bivalve molluscs.

260. **Watanabe, T.** October 1982. The production of food organisms with particular emphasis on rotifers. Report of the Training Course on Seabass Spawning and Larval Rearing, Songkhla (Thailand), 1-20 June 1982. Manila (Philippines). p. 26-28. Microfiche no: 8329831-E.
Project: RAS/74/013 - South China Sea Fisheries Development and Coordinating Programme. Workshop Report SCS/GEN/82/39.

The results of trials on the mass production of rotifers (Brachionus plicatilis) as food organisms for red sea bream (Pagrus major) are presented. Methods of rotifer production in Japan are also described.

LATIN AMERICA AND THE CARIBBEAN

APOYO A LAS ACTIVIDADES REGIONALES DE ACUICULTURA PARA AMERICA LATINA Y EL CARIBE

261. **Campos Baca, L.; Tacon, A.G.J.** November 1989. El alimento y la alimentacion de peces y camarones en la region amazonica del Peru. Antecedentes y estado actual. La Nutricion y la Alimentacion en la Acuicultura de America Latina, por C.A. Martinez Palacios, C. Chavez de Martinez & M.A. Olvera Novoa. Brasilia (Brazil). p. 20-37. Microfiche no: 303841.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Documento de Campo 17.

The paper reviews the food and feeding strategies employed by the public and private sector fish farms within the Amazon region of Peru. Information is provided on the public institutions engaged in aquaculture development within the region, the aquaculture species cultured, the proximate composition of the major feed ingredients available within the region, together with the farming and feeding practices employed for the culture of Colossoma, Pyaractus, Brycon, Prochilodus, Potamorhina, Astronotus, Tilapia, Macrobrachium and carp.

262. **Ceballos Orozco, L.; Velazquez Escobar, M.A.** May 1988. Perfiles de la alimentacion de peces y crustaceos en los centros y unidades de produccion acuicola en Mexico. Pachuca (Mexico). 139 p. Microfiche no: 303845.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe.

The report analyzes the feeding strategies employed by the public and private sector fish and shrimp farms within Mexico. Feeding strategies are evaluated on an individual species basis for salmonids, carps, Tilapia, catfish, penaeid shrimp and freshwater prawns. For each species information is provided on the geographical location of the major farms, the fertilization and feeding methods employed, including problems and constraints, and recommendations for improvements.

263. Cunha da Silva, J.R.M.; Nogueira, A.L. de M. August 1988. Perfil da alimentacao nas fazendas de criacao de camaroes marinhos e de agua doce do Brasil. Sao Paulo (Brazil). 87 p. Microfiche no. 311539.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe.

The report is concerned with an evaluation of the feeding strategies employed within the private and public sector marine shrimp and freshwater prawn farms within Brazil. For both shrimps and prawns information is provided on the historical development of the industry, together with technical data on hatchery and grow-out rearing techniques, and fertilization and feeding strategies for all stages of the shrimp or prawn life cycle. Recommendations for improvements of farm feed management practices are given.

264. de Morcillo, E.E.; de Clunie, A.K.; de Velotti, A.B.; Rivera, M.; Montes, B.; Frias, A. November 1989. Efectos de la utilizacion de diferentes reimenes de alimentacion aplicando alimento artificial en la produccion larval de Macrobrachium rosenbergii. La Nutricion y la Alimentacion en la Acuicultura de America Latina, por C.A. Martinez Palacios, C. Chavez de Martinez & M.A. Olvera Novoa. Brasilia (Brazil). p. 96-103. Microfiche no: 303841.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Documento de Campo 17.

The paper summarizes the results of a hatchery feeding trial with Macrobrachium rosenbergii using dried whole shrimp meal as a partial or total replacement for Artemia salina during the larval rearing cycle. The trial was conducted using 500-litre circular rearing tanks and an initial larval stocking density of 80-larvae/litre. The results indicated that under the rearing conditions employed larval M. rosenbergii did not survive and grow on the dried shrimp meal diet.

265. Fenucci, J.L. August 1988. Manual para la cria de camarones peneidos. Brasilia (Brazil). 93 p. Microfiche no: 288919.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Documento de Campo 8.

The document is written as a manual on Penaeid shrimp farming and discusses maturation, breeding and grow-out techniques for shrimp, and in particular culture techniques for American shrimp species. A detailed description of the American hatchery system and its modifications is presented. The manual also includes the description of microalgal culture techniques and a key for the identification of penaeid larval stages and substages. Information is also included on the various dietary feeding strategies for shrimp at all stages of the life cycle.

266. Garcia Carbajal, E.O. November 1989. La alimentacion de los peces cultivados en la region Andina del Peru. La nutricion y alimentacion en la acuicultura de America Latina - Una diagnosis, por C.A. Martinez Palacios, C. Chavez de Martinez & M.A. Olvera Novoa. Brasilia (Brazil). p. 15-19. Microfiche no: 303841.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Documento de Campo 17.

The paper reports on the feeding practices employed by public sector and private sector rainbow trout farms within the Andean region of Peru, including methodologies, problems and suggestions for improvements.

267. Garcia Carbajal, E.O.; Rodriguez Achung, F. November 1989. Atlas de ubicacion de los recursos agropecuarios en el Peru - Resumen. La Nutricion y la Alimentacion en la Acuicultura de America Latina - Una diagnosis, por C.A. Martinez Palacios, C. Chavez de Martinez & M.A. Olvera Novoa. Brasilia (Brazil). p. 66-79. Microfiche no: 303841.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Documento de Campo 17.

The paper summarises the reports of Garcia Carbajal and Rodriguez Achung concerning the geographical location, production and availability of agricultural products and wastes in Peru, including the Amazon region, which could in turn be used within aquaculture feeding strategies for farmed fish and shrimp.

268. **Licona de Macedo, G.; Gonzalez de Paniza, L.; Sanchez, A.** November 1989. Atlas de ubicacion de los recursos agropecuarios en la Republica de Panama- Resumen. La Nutricion y la Alimentacion en la Acuicultura de America Latina - Una diagnosis, por C.A. Martinez Palacios, C. Chavez de Martinez & M.A. Olvera Novoa. Brasilia (Brazil). p. 80-95. Microfiche no: 303841. Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Documento de Campo 17.

The paper summarizes the geographical location, production and utilization of the major agricultural products, including wastes, within the Republic of Panama which could in turn be used within aquaculture feeding strategies. Information is also presented on the status of the animal feed manufacturing industry and aquaculture sector.

269. **Martinez Palacios, C.A.; Chavez de Martinez, C.; Olvera Novoa, M.A.** November 1989. La nutricion y alimentacion en la acuicultura de America Latina. Una diagnosis. Brasilia (Brazil). 191 p. Microfiche no: 303841.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Documento de Campo 17.

The report summarizes the activities of Project in the field of aquaculture nutrition and feeding under the following headings: 1) training courses, 2) farm feeding profiles for fish and shrimp, including shrimp and prawns in Brazil, and fish and shrimp/prawns in Mexico and Peru, 3) support to aquaculture research in Panama, including hatchery feeding trials with marine shrimp and freshwater prawns, 4) national agricultural feed surveys, including country surveys for Panama, Mexico and Peru, 5) current situation concerning the food and feeding of Tilapia, salmonids, freshwater prawns, marine shrimp, and indigenous fish species in Latin America, and 6) problems faced by the aquaculture feed manufacturing sector in Latin Amercia.

270. **Morales R, V.; Quiros R.; Sainz de Mendez, I.; Sousa, E.** November 1989. Efectos de la utilizacion de diferentes dietas aplicando alimento seco micronizado en la produccion larval de Penaeus vannamei. La Nutricion y Alimentacion en la Acuicultura de America Latina - Una diagnosis, por C.A. Martinez Palacios, C. Chavez de Martinez & M.A. Olvera Novoa. Brasilia (Brazil). p. 104-125. Microfiche no: 303841.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Documento de Campo 17.

The paper summarizes the results of four hatchery feeding trials conducted with Penaeus vannamei in which dried shrimp meal (made from ground P. vannamei) was evaluated as a possible dietary replacement for Artemia salina nauplii. Six dietary treatments were tested in triplicate during the first three rearing cycles using a combination of algae (Chaetoceros gracilis and Tetraselmis chuii), marine yeast (Fleischman Yeast 7B) and Artemia nauplii. All experiments were conducted within 500-litre circular rearing tanks housed within an indoor hatchery using an initial shrimp stocking density of 60 larvae/litre. Of the various feeding regimes tested the highest larval survival (71.46 percent survival to PL-1) and lowest production feeding cost was recorded for the treatments fed algae, marine yeast and dried shrimp meal (the latter totally replacing Artemia).

271. **Palomo Martinez, G.G.; Arriaga Becerra, R.** May 1988. Atlas de ubicacion de productos agropecuarios utilizables en la planificacion y desarrollo de la acuicultura en Mexico. Pachuca (Mexico). 103 p. Microfiche no: 303847.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe.

The report is a survey of the agricultural products available in Mexico for aquaculture planning and development. Presented in the form of an illustrated atlas, information is presented under the following headings: 1) country profile, including geography and climate, demography, economy, communications and transportation, 2) agricultural and industrial products, by-products and wastes, including geographical location, production, utilization, cost and composition, 3) industrial manufacturers of animal feeds and fertilizers, including location, ownership, production and products, and 4) potential usage of byproducts and wastes for aquaculture.

272. **Sorgeloos, P.; Lavens, P.; Leger, P.; Tackaert, W.; Versichele, D.** 1986. Manual para el cultivo y uso de artemia en acuicultura. Brasilia (Brazil). 312 p. Microfiche no: 288921.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Documento de Campo 10.

The report is a translation of a manual for the culture and use of brine shrimp Artemia in aquaculture, published by the Artemia Reference Centre, State University of Ghent (Belgium). The manual presents a synthesis of current knowledge on the use of Artemia in aquaculture, with the emphasis on practical applications. The following topics are covered: biology and ecology of Artemia; cyst morphology and metabolism; collection, processing and preservation of cysts; nauplii and decapsulated cyst production for use as feed in hatchery systems; use of metanauplii, pre-adults and adults as feed; intensive culture of Artemia; and natural production of Artemia.

273. **Tacon, A.G.J.** June 1987. The nutrition and feeding of farmed fish and shrimp; a training manual. 1: The essential nutrients. Brasilia (Brazil). 126 p. Microfiche no: 88X00154.
Project: GCP/RLA/075/ITA. Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Field Document 2.

The classification, structure and biological function of the essential nutrients are described: proteins and amino acids, lipids, carbohydrates, vitamins, minerals, and energy. The quantitative dietary nutrient requirements of fish and shrimp are critically reviewed, and suggestions made for dietary nutrient levels within practical complete diets for carnivorous and omnivorous fish and shrimp species.

274. **Tacon, A.G.J.** September 1987. The nutrition and feeding of farmed fish and shrimp; a training manual. 2: Nutrient sources and composition. Brasilia (Brazil). 137 p. Microfiche no: 88X00527.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Field Document 5/E.

The principles of feed and fertilizer analysis are described, and the chemical composition of various potential feed ingredients and fertilizers presented; including the cereal grains and by-products, oil-bearing seeds and by-products, grain legumes, green fodder crops, roots and tubers, fruits, aquatic macrophytes, miscellaneous plant feedstuffs, single-cell proteins, animal by-products, invertebrates, chemical fertilizers, and organic manures. Information is also presented on the major dietary feed additives, including feed antioxidants, binders, pigments, and dietary feeding stimulants. In addition, a glossary of nutrition feed milling terms and feed ingredient definitions is presented.

275. **Tacon, A.G.J.** January 1988. The nutrition and feeding of farmed fish and shrimp. A training manual. 3: Feeding methods. Brasilia (Brazil). 216 p. Microfiche no: 288917.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Field Document 7.

The feeding methods employed for the production of farmed fish and shrimp are presented. Complete diet feeding methods are described, including formulation procedures, feed manufacture and storage, larval feeding, dietary feeding allowances, and feed economics. In addition, information is presented concerning fertilization and supplementary diet feeding methods, including pond preparation techniques, chemical fertilization, manure fertilization through direct

application, livestock integration, composting and fermentation, and supplementary diet formulation and feeding practices.

276. **Tacon, A.G.J.; Maciocci, G.; Vinatea, J.E.** June 1987. National Agriculture Feed Surveys (NAFS) for aquaculture planning and development in Latin America and the Caribbean. 1: Guidelines. Brasilia (Brazil). 15 p. Microfiche no: 88X00153.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Field Document 1.

Guidelines are presented for conducting a National Agricultural Feed Survey (NAFS) within a Latin American or Caribbean country so as to enable the aquaculture producer, public or private, to develop his or her own aquaculture feeding strategy. Presented in the form of an illustrated atlas, the NAFS report is designed to provide the user with information on the fertilizer and feed resources of the country, where they are geographically located, how much is available and when, who is currently using this resource and how, the composition and cost of this resource at source and with transportation, an assessment of the existing agriculture, fisheries (including aquaculture) and animal feed manufacturing sectors, together with background information on the social, cultural, economic and political environment within the country.

277. **Torrentera, B.L.; Tacon, A.G.J.** April 1989. La Produccion de alimento vivo y su importancia en acuicultura. Brasilia (Brazil). 97 p. Microfiche no: 303837.
Project: GCP/RLA/075/ITA - Apoyo a las Actividades Regionales de Acuicultura para America Latina y el Caribe. Documento de Campo 12.

The report is concerned with the production of live food organisms and their importance in aquaculture and is presented under the following headings: 1) nutritional importance of live food organisms, 2) culture of micro-algae, 3) culture of rotifers, 4) culture of Artemia, 5) culture of copepods, and 6) culture of Daphnia and Moina.

PROYECTO PARA EL ESTABLECIMIENTO DEL CENTRO REGIONAL LATINOAMERICANO DE ACUICULTURA

278. **Cantelmo, O.** 1985. Nutricion y alimentacion artificial de peces en el CERLA. Informe de la segunda reunion del comite asesor del proyecto RLA/76/010-PNUD/FAO para el Establecimiento del Centro Regional Latinoamericano de Acuicultura (CERLA). Pirassununga (Brazil). p. 230-236. Microfiche no: 86X01264.
Project: RLA/76/010 - Proyecto para el Establecimiento del Centro Regional Latinoamericano de Acuicultura.

The paper summarizes the research activities of the author on the nutrition and feeding of fish at the Latin American Regional Aquaculture Centre in Pirassununga, Brazil. Information is presented on the potential feed ingredients available within the municipality of Pirassununga for fish feeding and concerning the growth response and feed efficiency of Pacu (Colossoma mitrei) fed a variety of different dietary feeding regimes and diets.

III. INTER-REGIONAL PROJECT REPORTS

AQUACULTURE DEVELOPMENT AND COORDINATION PROGRAMME

279. **Aquaculture Development and Coordination Programme (ADCP).** 1980. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). 400 p. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The report is divided into 26 chapters based on the lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, including 1) digestion in teleost fishes, 2) nutritional bioenergetics in fish, 3) proteins and amino acids, 4) lipids and fatty acids, 5) carbohydrates, 6) the vitamins, 7) the minerals, 8) feedstuffs, 9) ingredients for fish feed manufacture in the United States, 10) antioxidants in compound feeds, 11) adventitious toxins in feeds, 12) unconventional feed ingredients for fish feed, 13) storage problems of feedstuffs, 14) stability of micro-ingredients in fish feed, 15) fish feed formulation, 16) linear programming in fish diet formulation, 17) material flow in feed manufacturer, 18) feed milling processes, 19) the dravo process for non-compacting feed, 20) effects of processing on the nutritional value of feeds, 21) manufacturing compounded feeds in developing countries, 22) practical fish diets, 23) novel diets for aquaculture, 24) microencapsulated egg diets for fish larvae, 25) experimental design in diet studies, and 26) quality control in fish feed manufacturing.

280. **Aquaculture Development and Coordination Programme (ADCP).** 1981. Outline research programmes for the regional aquaculture lead centres in Asia. Pt. III: Programme of research at the Regional Lead Centre for Integrated Fish Culture, Wuxi, the People's Republic of China. Rome (Italy). 2 p. Microfiche no: 8215597-E.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 81/15.

The report presents outline proposed research programmes for the Regional Aquaculture Lead Centre for Integrated Fish Culture in Wuxi, Jiangsu Province. The report is presented under three major headings, namely research needs, research problems and research approaches. The major research approaches outlined included: 1) collection and analysis of existing data; 2) tanks and yard-scale experiments; 3) studies of animal manures; 4) studies of green manures; 5) pond dynamics; 6) straw and other high fibre substrates; 7) fish stock and stocking rates; 8) silt and pond bottom studies; and 9) experimental studies and economic evaluations.

281. **Aquaculture Development and Coordination Programme (ADCP).** 1983. Fish feeds and feeding in developing countries; an interim report on the ADCP Feed Development Programme. Rome (Italy). 100 p. Microfiche no: 8335657-EC.
Project: INT/81/031 - Aquaculture Development and Coordination Programme. ADCP Technical Report 83/18.

Under ADCP's Fish Feed Development Programme, a survey of the availability of ingredients for fish and shellfish feeds was undertaken in 11 countries. Information on the various feedstuffs, their composition, nutritional value, prices and availability are summarized. Although some of the feed stuffs have anti-nutritional or toxic factors, the majority of them are useful as ingredients in fish and shellfish diets. Making use of the facilities in the FAO/UNDP Network of Aquaculture Centres and other Projects and the nutrient specifications for cultivated species, a number of least-cost feeds using locally available ingredients were formulated, prepared and tested. A micro-encapsulated egg diet proved efficient as a larval feed for rohu, Clarias, sandgoby and Pangasius. The results of feeding experiments with fingerlings and adult fish are summarized. Based on experience so far, a number of 24-30 percent protein diets for warm water fishes and 40-50 percent protein diets for rainbow trout fry, fingerlings and adults are proposed. The

existing feed milling industries in the countries surveyed are briefly described and their ability to undertake fish feed manufacture discussed.

282. **Aquaculture Development and Coordination Programme (ADCP).** 1979. Training in fish feed technology. Report of the FAO/UNDP Training Course in Fish Feed Technology, held in the University of Washington, Seattle, Washington, USA., 9 October - 15 December 1978. Rome (Italy). 20 p. Microfiche no: 43529.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 79/8.

Sixteen participants from ten countries (Bangladesh, Egypt, Ghana, Indonesia, Kenya, Nepal, Nigeria, the Philippines, Sri Lanka and Thailand) attended a Training Course in Fish Feed Technology held in Seattle, State of Washington, USA. The Course was organized and conducted by the FAO/UNDP Aquaculture Development and Coordination Programme in collaboration with the College of Fisheries, University of Washington. Training activities included lectures, tutorials, laboratory work, country problems discussions and field visits. Eighty-two lectures on subjects dealing with: digestion anatomy and physiology, nutritional bio-energetics and biochemistry, feedstuffs, feed formulation, feed milling technology, practical diets and quality control, were presented by specialists. All the participants described the status of intensive aquaculture in their respective countries and the constraints on its development with particular reference to feed supply and diet development.

283. **Aquaculture Development and Coordination Programme (ADCP).** 1980. Outline research programme for the African Regional Aquaculture Centre - Port Harcourt, Rivers State, Nigeria. Report of a task force sponsored by the Aquaculture Development and Coordination Programme, 3-19 February 1980. Rome (Italy). 21 p. Microfiche no: 8109019-E.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/12.

The report outlines the research programme for the African Regional Aquaculture Centre in Port Harcourt, Nigeria, and is presented under the following headings: 1) culture of Tilapia and Clarias in freshwater ponds, 2) fish culture in brackishwater ponds, 3) oyster culture in coastal areas, 4) fish culture in open waters, 5) fish culture in combination with animal husbandry, and 6) shrimp culture in coastal ponds. Within each proposed programme activity background information is presented together with specific research needs and approaches.

284. **Aquaculture Development and Coordination Programme (ADCP).** 1978. Outline of an applied research and experimental development programme for the Latin American Regional Centre for Aquaculture. Rome (Italy). 30 p. Microfiche no: 41729.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 78/5.

The report outlines the proposed structure for applied research and experimental development at the Latin American Regional Centre for Aquaculture in Pirassununga, Brazil and associated sub-centres in support of aquaculture development in Latin America, and is presented under the following headings:1) background to the establishment of the Centre, 2) role of the Centre, 3) pond culture of indigenous fish species, 4) culture of tilapia in ponds in the plains, 5) cage culture of tilapia in lakes and reservoirs, 6) culture of carps, 7) pond culture of trout in upland areas, 8) raft and long-line culture of oysters and mussels, 9) shrimp farming in brackish water, 10) polyculture, 11) expertise to be thought in staffing, and 12) facilities required to support the programme.

285. **Aquaculture Development and Coordination Programme (ADCP).** 1980. Outline research programmes for the regional aquaculture lead centres in Asia. Parts I and II. Rome (Italy). 47 p. Microfiche no: 8109021-E.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/14.

The report outlines the proposed applied research and experimental studies for the Regional Aquaculture Lead Centres in India, Thailand and the Philippines, and is presented under the following headings: A. Regional Aquaculture Lead Centre, Dhauli (Bhubaneswar), India, 1) introduction, 2) background, including fertilizing and feeding, 3) research needs, and 4) research approach; B. Regional Aquaculture Lead Centre, Bangkok, Thailand, 1) introduction, 2) Clarias and Ophicephalus pond culture, 3) Macrobrachium culture, 4) cage culture of Pangasius, 5) Trichogaster culture in rice fields, 6) pond culture of Puntius, 7) mussel culture, and 8) oyster culture; and C. Regional Aquaculture Lead Centre, Philippines, 1) introduction, 2) some general problems and their solutions, including fertilization and feeding, 3) shrimp culture in ponds, 4) milkfish culture in ponds, including food and feeding, and 5) culture of mullets and other brackishwater fish in ponds.

286. **Chow, K.W.** 1980. Storage problems of feedstuffs. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 215-224. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper reviews the problems caused by insects and micro-organisms in feedstuffs during prolonged storage, and discusses the individual deteriorative changes caused by these organisms and by other environmental factors in stored feedstuffs.

287. **Chow, K.W.** 1980. Manufacturing compounded feeds in developing countries. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 325-329. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper presents guidelines for the establishment of a feed mill within a developing country, from the concept of a feed mill, the physical requirements of the feed mill, to the planning and implementation of the project.

288. **Chow, K.W.** 1980. Microencapsulated egg diets for fish larvae. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 355-361. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper discusses the merits of using microencapsulated egg diets for fish larvae. Information is provided on the nutritional characteristics of chicken egg and three preparation procedures are described.

289. **Chow, K.W.** 1980. Quality control in fish feed manufacturing. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 369-385. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper describes quality control in fish feed manufacture, including quality control procedures, raw material and finished product storage, and methods of analysis.

290. **Chow, K.W.** 1983. Fabrication d'aliments pour poissons en Tunisie. Etude du potentiel aquacole et propositions pour une politique de developpement de l'aquaculture en Tunisie. Rapport d'une mission TCP/ADCP en Tunisie, mars-juin 1982. Rome (Italy). p. 85-96. Microfiche no: 8332301-327-F.
Project: INT/81/031 - Aquaculture Development and Coordination Programme. ADCP Mission Report 83/21.

The paper deals with the manufacture of fish feeds in Tunisia. Information is provided on the availability of fishery products, including fish meal, and other feed ingredients and by-products in Tunisia for use within aquaculture feeds for seabass, gilthead bream and mullet. Animal feed manufacturing industry within Tunisia is briefly reviewed and existing aquaculture feeding practices employed within Tunisia described. Recommended experimental moist diet formulations and feeding regimes for mullet, European seabass and seabream, and feed equipment purchases are presented.

291. **Chow, K.W.; Halver, J.E.** 1980. Carbohydrates. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 55-63. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper summarizes the classification and chemistry of the major carbohydrate groups and reviews carbohydrate metabolism within fish, including energy transformation.

292. **Chow, K.W.; Rumsey, G.L.; Waldroup, P.W.** 1980. Linear programming in fish diet formulation. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 241-286. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The use of the linear programming (LP) technique for fish feed formulation is described, including LP basics, the preparation of data inputs, the solution of a catfish diet formulation model, the modification of data decks by the revise programme, and the use of new parametric linear programming techniques.

293. **Chow, K.W.; Schell, W.R.** 1980. The minerals. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 104-108. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

Information is presented on the distribution, absorption, metabolism, deficiency symptoms and feed availability of calcium, phosphorus and magnesium in fish. Summary data is also provided on the known dietary mineral requirements of cultured fish.

294. **Csengeri, I.** 1984. Artificial feeding in intensive fish culture. Inland Aquaculture Engineering - Lectures presented at the ADCP Inter-regional Training Course in Inland Aquaculture Engineering, Budapest, 6 June - 3 September 1983. Rome (Italy). p. 425-436. Microfiche no: 85M01512.
Project: INT/81/031 - Aquaculture Development and Coordination Programme. ADCP Technical Report 84/21.

The paper provides summary information on the classification of fish according to feeding habit, temperature optima of fish for growth, the utilization and partition of feed energy by fish, the protein and amino acid requirements of fish, the vitamin requirements and deficiency symptoms of fish, the formulation and production of a purified vitamin test diet, and different formulations for measuring feed efficiency and growth rate in fish.

295. **Halver, J.E.** 1980. Proteins and amino acids. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 31-40. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper provides general information on the classification, structure and chemical property of proteins, summarizes protein digestion and metabolism, describes the protein and amino acid requirements of the major cultured fish species, and discusses the supplementation of diets with synthetic amino acids.

296. Halver, J.E. 1980. Lipids and fatty acids. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 41-53. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The effect of environmental conditions and diet on the fatty acid composition of fish is described and the dietary lipid and fatty acid requirements of cultured fish presented. In addition information is provided on the metabolism of fatty acids within fish and the possible anti-nutritional aspects of dietary lipids.

297. Halver, J.E. 1980. The vitamins. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 65-103. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper presents a thorough review of vitamin nutrition in fish, including vitamin chemistry, function, deficiency syndromes, dietary requirements, sources and protection, antimetabolites and inactivation, and clinical assessment for 11 water-soluble and 4 fat-soluble vitamins.

298. Hardy, R.W. 1980. Fish feed formulation. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 233-239. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The basic principles of fish feed formulation are briefly described, including the square method for balancing the dietary crude protein level of feeds, formulation steps and best-buy techniques. A worksheet for diet formulation is also presented.

299. Hardy, R.W. 1980. Experimental design in diet studies. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 363-366. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper presents guidelines for experimental design in diet studies, including how to determine the number of replicates required for an experiment, testing for significant differences between treatments, transformations, and preparing isonitrogenous, isocalorific and control diets.

300. Harris, L.E. 1980. Feedstuffs. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 111-170. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper provides information on feed nomenclature, the systematic collection and recording of data on feed composition, and on the calculations used for the summarization of feed composition data. The chemical and nutritional characteristics of individual energy and protein feeds are described, and information provided on dietary vitamin and mineral supplements (including units of potency) and concerning miscellaneous feed additives.

301. **Hastings, W.H.; Higgs, D.** 1980. Feed milling processes. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 293-313. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper describes the different grinding, mixing and pelleting techniques and options available to the commercial feed manufacturer, from the initial grinding of incoming ingredients to the production of a floating pelleted fish diet by extrusion.

302. **Kestemont, P.; Micha, J.C.; Falter, U.** 1989. Les methodes de production d'alevins de Tilapia nilotica. Rome (Italy). 140 p. Microfiche no: 303045.
Project: INT/81/031 - Aquaculture Development and Coordination Programme. ADCP Technical Report 89/46.

The report details methods for the mass production of Tilapia nilotica fingerlings in Africa and is presented under the following headings: 1) biology of Tilapia nilotica, 2) present techniques employed for reproduction and production of fingerlings in ponds, cages, raceways and aquariums, and 3) conclusions and recommendations. Methods employed for the food and feeding of broodstock, fry and fingerlings are described together with broodstock handling techniques.

303. **Lovell, R.T.** 1980. Practical fish diets. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 333-350. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper presents information on the use of wet diets for research and practical feeding, including the formulation of laboratory purified test diets and the formulation of practical diets based on the use of lactic acid fermented fish waste. Channel catfish feeds and feeding is then discussed in detail from the point of view of dietary nutrient requirements, feed manufacture and feeding practices. Finally, information is also presented on crustacean diets.

304. **Majoros, F.** 1984. Fish feed production, storage and transportation. Inland Aquaculture Engineering - Lectures presented at the ADCP Inter-regional Training Course in Inland Aquaculture Engineering, Budapest, 6 June - 3 September 1983. Rome (Italy). p. 437-444. Microfiche no: 85M01512.
Project: INT/81/031 - Aquaculture Development and Cordination Programme. ADCP Technical Report 84/21.

The production of manufactured feeds for cultured fish is described, including cereal post harvest technology and storage, driers and drying techniques, feed storage, feed processing machinery, sieving and grinding, mixing, pelleting, drying machinery, and machinery for feed transportation.

305. **New, M.B.** 1987. Feed and feeding of fish and shrimp. A manual on the preparation and presentation of compound feeds for shrimp and fish in aquaculture. Rome (Italy). 280 p. Microfiche no: 87MO1479.
Project: INT/81/031 - Aquaculture Development and Coordination Programme. ADCP Technical Report 87/26.

This manual has been prepared as an easy-to-read guide to the choice, manufacture, storage and use of feed in small-scale aquaculture. It was written for fish and crustacean farmers, extension officers and university aquaculture students. Feeding increases the productivity of aquaculture farms but it constitutes the highest single cost item of running expenditure. Care in its use is therefore imperative. The manual attempts to answer the basic questions likely to be asked by those intending to apply feed as part of a programme to intensify production. The main sections of the manual deal with the need to feed, feed composition, choice of feeds, feed manufacture, nutritional requirements, storage, feeding practice, record keeping and likely problems. Eighteen

appendices cover a wide range of related topics including examples of feed formulae, feed machinery, feeding devices, simple tables of feed composition, binders, feeding tables and analytical methods.

306. **Pigott, G.M.** 1980. The Dravo process for non-compacting feed. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 315-320. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The Dravo pelletizing technique is described for the manufacture of non-compacted fish feed. The advantages of this processing technique over conventional compaction pelleting techniques are discussed and a generalized flow diagram presented.

307. **Pillay, T.V.R.** 1979. Aquaculture development in China. Report on an FAO/UNDP aquaculture study tour to the People's Republic of China, 2 May - 1 June 1978. Rome (Italy). 74 p. Microfiche no: 8000457-E.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 79/10.

The report is presented under the following headings: 1) background to Chinese aquaculture development, 2) planning, organization and management of aquaculture, 3) financing and credit, 4) fish culture practices (including fertilization, feeding and pond management), 5) integrated farming of fish, crop and livestock, 6) fish cultivation in natural lakes and reservoirs, 7) fish farming in rivers, 8) marine aquaculture, 9) marketing, 10) education and training, 11) fisheries research, and 12) conclusions and recommendations.

308. **Raven, P.; Walker, G.** 1980. Ingredients for fish feed manufacture in the United States. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 171-175. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper lists and defines the major feed ingredients used for fish feed manufacture within the United States, including individual mill by-products, oil extractives, animal by-products and miscellaneous ingredients.

309. **Raven, P.; Walker, G.** 1980. Material flow in feed manufacturing. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 289-292. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

Material flow in feed manufacture is summarized, including receiving, processing, packaging, storage and distribution. A flow diagram of a typical feedmill is presented.

310. **Rumsey, G.L.** 1980. Antioxidants in compounded feeds. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 177-182. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper discusses the use of antioxidants in compound feeds, including criteria for selection, biological action and effect, and recommended inclusion levels within the finished feed.

311. Rumsey, G.L. 1980. Adventitious toxins in fish feeds. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 183-186. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper briefly discusses the major toxic factors or adventitious toxins which may occur in feeds, including the pesticides and chlorinated hydrocarbons, seed dressings, cross contaminants, salmonella and anti-nutritional factors.

312. Rumsey, G.L. 1980. Stability of micro-ingredients in fish feed. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 225-229. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The selection of micro-ingredient sources is discussed on the basis of particle size and flow characteristics, and their stability viewed on the basis of separation, under or over mixing, and the feed pelleting process employed.

313. Rumsey, G.L. 1980. Novel diets for aquaculture. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 351-353. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper introduces the topic of larval fish feeds, and in particular encapsulated diets and flake diets.

314. Schmidt, U.W. (1980). Integrated aquaculture in West Java. A socio-economic study of integrated farming of fish, livestock and crops by small farmers in West Java, Indonesia. Rome (Italy). 22 p. Microfiche no: 8113129-E.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Mission Report 80/11.

Economic and social efficiencies of the integrated fish farming systems carried out in West Java are considered, including the cost of fertilizers and feeding. Fish culture in combination with rice, aquatic vegetables and mendong as well as with ducks and chickens is discussed. Potential for development and planning for the development of integrated farming are also described.

315. Schmidt, U.W.; Vincke, M.M.J. 1981. Aquaculture development in Rwanda. Feasibility of small-scale rural fish farming. Rome (Italy). 71 p. Microfiche no: 8113131-E.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Mission Report 81/12.

The report discusses the technical, economic, social and financial feasibility of small-scale rural fish farming enterprises in Rwanda and the factors inhibiting higher productivity and expansion; it also indicates the nature and amount of inputs required to carry out an effective programme of development aimed at a significant increase in supplies at acceptable costs. Within the technical portion of the report information is presented on supplementary feeds, the fertilization of fish ponds, and expected fish yields. In addition, annexes are included on combined animal husbandry and fish culture, the use of agricultural and industrial waste products for supplementary feeding, feed formulae for fish in Rwanda, and finally on fertilizers.

316. Smith, L.S. 1980. Digestion in teleost freshwater fishes. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 3-18. Microfiche no: 8004149-201-EC.

Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper presents an overview of gut definition, anatomy and physiology, describes the characteristics of individual digestive enzymes and secretions, presents methods of analysis for digestion studies, and describes the digestive anatomy of rainbow trout, channel catfish, common carp and milkfish.

317. **Smith, R.R.** 1980. Nutritional bioenergetics in fish. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 21-27. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper presents an overview of energy metabolism in fish, including the major energy sources and the partition of feed energy, and summarizes the energy requirements of fish and the factors capable of altering energy needs.

318. **Spinelli, J.** 1980. Unconventional feed ingredients for fish feed. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 187-214. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The paper presents information on the formulation problems associated with the use of unconventional feedstuffs, and reviews the nutritive value for fish of soybean meal, single cell proteins, krill, poultry by-product meal, feather meal and insect larvae. Information is also provided on waste recycling and direct fertilization, and concerning the factors affecting the organoleptic properties of fish.

319. **Tacon, A.G.J.** 1985. Nutritional fish pathology. Morphological signs of nutrient deficiency and toxicity in farmed fish. Rome (Italy). 37 p. Microfiche no: 86M00004.
Project: INT/81/031 - Aquaculture Development and Coordination Programme. ADCP Technical Report 85/22.

A synthesis is presented of published data from a wide variety of sources relating to the morphological signs of nutrient deficiency and toxicity in farmed fish fed artificial diets. Derangements in protein, lipid, mineral and vitamin nutrition are described. Anti-nutritional factors, including adventious toxic factors, present in plant feedstuffs are examined.

320. **Tacon, A.G.J.** 1986. Larval shrimp feeding. Crustacean tissue suspension: a practical alternative for shrimp culture. Rome (Italy). 32 p. Microfiche no: 86M02193.
Project: INT/81/031 - Aquaculture Development and Coordination Programme. ADCP Mission Report 86/23.

An evaluation is made of a simple and inexpensive hatchery feeding strategy based on the use of a crustacean tissue suspension, and tested on Penaeus monodon at the Regional Lead Centre in the Philippines. The advantages and disadvantages of the system are examined. Although the current results indicate that the dry feed particles are consumed by the Penaeus larvae and possess a nutritional quality capable of sustaining larval growth and survival, further long term feeding trials are required. The results of the feeding trials conducted are presented.

321. **Varadi, L.** 1984. Mechanized feeding in aquaculture. Inland Aquaculture Engineering - Lectures presented at the ADCP Inter-regional Training Course in Inland Aquaculture Engineering, Budapest (Hungary), 6 June - 3 September 1983. Rome (Italy). p. 445-460. Microfiche no: 85M01512.
Project: INT/81/031 - Aquaculture Development and Coordination Programme. ADCP Technical Report 84/21.

The paper reviews on-farm fish feed storage facilities, feed transportation equipment, stationary feeding equipment (including demand and automatic feeders), and mobile feeding equipment (including feeding carts and feeding boats).

322. **Vincke, M.M.J.** 1980. Developpement de l'aquaculture au Viet Nam. Rapport d'une mission relative a la formulation d'un plan d'action, 25 juin - 14 juillet 1979. Programme de mise en valeur et de coordination de l'aquaculture. Developpement de l'aquaculture au Viet Nam. Rapport d'une mission relative a la formulation d'un plan d'action, 25 juin - 14 juillet 1979. Rome (Italy). 50 p. Microfiche no: 8003739-F.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Mission Report 80/7.

The report details the results of a mission on the formulation of an action plan for aquaculture development in Viet Nam and is presented under the following headings: 1) background information, 2) the Hanoi fishery enterprise, 3) fingerling production farms managed by the Hanoi fishery enterprise, including information on pond fertilization and feeding methods and costings, 4) natural and artificial lakes in the Hanoi region, 5) fishery cooperatives and state fish farms, including rizipisciculture and agropisciculture practices, and 6) conclusions and recommendations.

323. **Vincke, M.M.J.; Wijkström, U.N.** 1982. Notes sur l'economie de l'aquaculture en Cote-d'Ivoire. Rapport d'une mission en Cote-d'Ivoire. Rome (Italy). 72 p. Microfiche no: 8328493-F.
Project: INT/81/031 - Aquaculture Development and Coordination Programme. ADCP Mission Report 82/19.

The report details the results of a mission to evaluate the economics of aquaculture activities in the Ivory Coast. Particular attention is given to the economic evaluation of freshwater pond and cage/pen Tilapia farming systems, including an analysis of food and feeding costs.

324. **Walker, G.** 1980. Effects of processing on the nutritional value of feeds. Fish feed technology. Lectures presented at the FAO/UNDP Training Course in Fish Feed Technology, Seattle, Washington, 9 October - 15 December 1978. Rome (Italy). p. 321-324. Microfiche no: 8004149-201-EC.
Project: INT/76/016 - Aquaculture Development and Coordination Programme. ADCP Technical Report 80/11.

The effects of processing on the nutritional value of feeds and feedstuffs is discussed, including heat treatment, grinding, pelleting and crumbling processing techniques. Specific processing techniques employed for the destruction of naturally occurring toxins and inhibitors in cottonseed meal, soybean meal and linseed meal are described, and the effect of processing on the availability of vitamins and minerals summarized.

INTERNATIONAL TRAINING COURSES IN AQUACULTURE

325. **Coche, A.G.; Edwards, D.** (Editors). 1989. Selected aspects of warmwater fish culture - A compilation based on lectures presented at a series of FAO/AGFUND International Training Courses in Aquaculture hosted by Hungary in 1987 and 1988. Rome (Italy). 181 p. Microfiche no: 295729.
Project: GCP/INT/435/AGF - International Training Courses in Aquaculture.

The compilation summarizes the information presented during the three training courses regarding aquaculture in the following chapters: 1) Design and maintenance of pond fish farms; 2) Pond fish farms in Hungary; 3) Supplementary and complete feeds; 4) Integrated agriculture and fish production; 5) Prevention and control of fish diseases; 6) Transport of live fish; 7) Aspects of common carp culture; 8) Aspects of Chinese carp culture; 9) Culture of the Indian major carps; 10) Tilapias and their culture; 11) Biology and culture of African catfish; 12) Culture of Asian catfish and snakehead; and 13) Culture of European catfish.

326. **Edwards, D.** October 1988. Report. Training Course on Fish Foods and Feeding, 3. Szazhalombatta (Hungary), Szarvas (Hungary), 16 May - 12 Aug 1988. Rome (Italy). 35 p. Microfiche no: 89W01228-E.
Project: GCP/INT/435/AGF - International Training Courses in Aquaculture. Field Document 3.

The third training course on fish food and feeding was held in Hungary and attended by 18 participants from 14 countries in Asia, Africa and the Caribbean. The course programme and evaluation is presented together with the names and addresses of the participants.

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